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AIR MONITORING AND SAMPLING NETWORKS. PROCEEDINGS OF THE 1959 SEMINAR

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

1960

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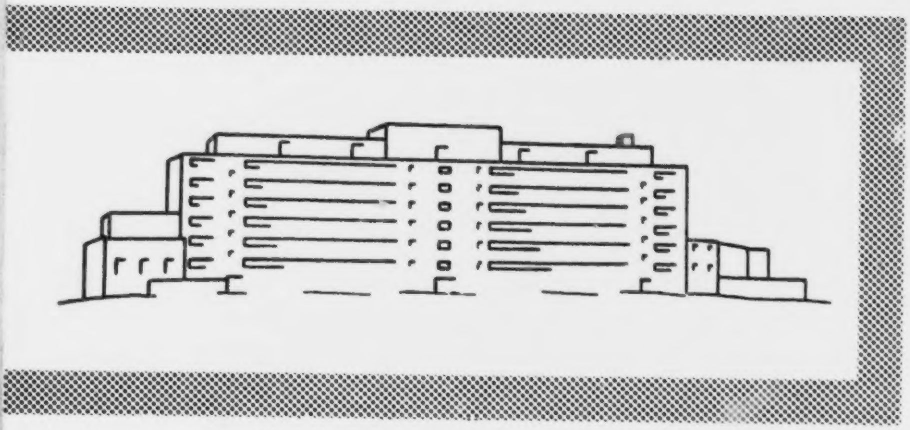
Proceedings of the 1959 Seminar



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TECHNICAL REPORT
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AIR MONITORING AND SAMPLING NETWORKS

Proceedings of a seminar held at the Robert A. Taft Sanitary Engineering Center, Monday and Tuesday, November 23-24, 1959.

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service
Bureau of State Services
Division of Engineering Services

ROBERT A. TAFT SANITARY ENGINEERING CENTER
Cincinnati 26, Ohio

1960

I

The objective of this seminar is:

To bring together people currently engaged in the operation of air sampling and monitoring networks and others who may have an interest in the development of such networks for the purpose of exchanging information on the objectives, organization, and operation of networks, and the analysis and utilization of data obtained from their operation.

Sponsored by
National Air Sampling Network
Air Pollution Engineering Research

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

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INTRODUCTION

CHAIRMAN TETZLAFF: This is the first session of a two-day Seminar on Air Monitoring and Air Sampling Networks. We are glad to have with us some who are operating their own air sampling networks and others who operate air sampling stations in our network. We know that we will benefit from your discussions, from your ideas on our network, and on your own, and I think the net result will be an improved activity on the part of all of us.

The program, as usual, is a very full one. There are only two days, and there is very little time without scheduled activities.

There will be a tour of the Center a little later this morning, and I suppose if we break up early tomorrow, there will be a little more time for you to discuss questions of special interest to you.

Each of the discussants has allowed some time in the period which has been allotted to him for discussion. Now, that is the real purpose of this Seminar, to get from you your comments on what is being done in your own communities, or by us, so that we will have some ideas as to how to achieve an improved operation.

Now, I would like to present to you the Director of the Robert A. Taft Sanitary Engineering Center, who favors us at each of these Seminars with some well-chosen words.

I would like to introduce to you Assistant Surgeon General Harry G. Hanson.

MR. HANSON: It is a real pleasure to have all of you here, and to be host to you. I think the planning went off a little bit -- it looks like a better time for a precipitation network seminar. But we will have to make the best of it, and hope that the weather is at least good for picture-taking tomorrow.

I am sure that there are as many ideas about how an air pollution network ought to be operated and what it ought to encompass as there are people here, at least. Some of you may have more than one idea of how it should be operated. This first seminar is sort of a stock-taking enterprise. It is good to take stock now and then and see whether what you are doing with public monies is the most efficient and serves overall needs the best.

Therefore this seminar will endeavor to look at a few years of cooperative work in operating a national network to see what it has yielded, to confront ourselves with some of the questions that have arisen concerning it, and to see if we can come to any common feeling with respect to any, or some, parts of it, and what it ought to be.

I have had the opportunity to glance at John Ludwig's paper, for example, and I know that in it are raised more questions than you could answer if you stayed here for six months.

Frank mentioned that the schedule even superficially locks busy. If you address yourselves to the kinds of questions that many of you are going to raise here, you will have much more than you can do in the time allotted.

We are particularly pleased to see such a representative group of people from state, local levels, and industry. We are very happy to have Mr. Arnold Arch, the Executive Secretary of the Air Pollution Control Association here, and to have not only some of our headquarters bureaucrats, but also a good representation from our regional office grass roots staff of the Public Health Service.

I simply wish you a very profitable session. Make yourselves at home, and if we can do anything for you personally as well as officially, let us know.

Thank you.

CHAIMAN TETZLAFF: Thank you, Harry.

Our next welcomer is someone whom I think you all know. I am not at all certain that he still knows us; he has been gone so long, almost two months, in England and Europe.

We occasionally are fortunate enough to have the opportunity to send some of our people over there. This was the occasion of a Diamond Jubilee Conference of the British National Society for Clean Air.

There are a lot of things that we have learned from the programs in Europe, and perhaps he might allude to some of those. We will see if he still knows us.

Mr. Arthur C. Stern, the Chief of the Air Pollution Engineering Research Activities here at the Center. Arthur.

MR. STERN: We have from time to time, with regard to the national network, stuck our chin out and said "Please take some pokes at us; tell us what is wrong."

The first time we did it was very early in the game, at an Air Pollution Control Association Meeting in Detroit. We were just starting this national air quality monitoring effort, and we got folks together and said, "Tell us how it should be operated."

By preparing and presenting papers at various technical meetings and inviting comments and criticism, we have tried to continually keep our chin out and say, "Tell us what we are doing wrong -- and if we are doing right, tell us that, too."

The current issue of Journal of the Air Pollution Control Association carries a paper reporting some of the results of the network. It is followed by a criticism by Dr. Quebedeaux. This is the kind of thing that we encourage. We want people to tell us, so far as the national network is concerned, what is wrong as well as what is right.

We also want to tell those folks who are associated with state and local activities what we think they should be doing. We feel that state and local efforts in air quality monitoring, are far from adequate. One of the things that we hope to accomplish at this seminar is to sell the notion that there should be an increase in the pace of state and local monitoring.

In view of the introduction I received, I will have to take at least a minute or two to give you a very rapid report of air quality monitoring abroad.

Only in Great Britain is there anything approaching a national air quality monitoring scheme. Most of you know that this scheme has been going on for some 30 or 40 years, and is somewhat different from ours in that there is no central laboratory used. Each cooperating group does its own laboratory work. The principal emphasis has been and still is on dust fall.

The people who operate the British network are considering conversion to the type of a network that we have. Yet at the same time we have been very actively looking at their network to see if we want to convert to their type of network. Obviously, there is real room for interchange of ideas.

The British may adopt a high vol particulate measuring scheme somewhat similar to that which we are using. We, working with you in the cities and the states, will try to turn more and more of the laboratory work, particularly in gas sampling and analysis, over to the local agencies, rather than trying to do it all centrally. Thus, there may be a merging of the philosophies that have been used here, and those which have been used abroad.

As far as local measuring networks are concerned, we found that most of the British cities have fairly active networks. There are active ones in the Ruhr in Germany, in Paris, and in Milan.

CHAIRMAN TETZLAFF: Thank you, Arthur.

The first scheduled discussant is -- the Assistant Chief of the Air Pollution Engineering Research Staff here at the Center, Dr. John H. Ludwig, who will talk to us about the Seminar, the way it is to be operated, what we want to acquire from it; and he will also talk to us about the network objectives.

SEMINAR AND NETWORK OBJECTIVES

J. H. Ludwig

DR. LUDWIG: The objectives of sampling station networks and the resulting physical and chemical analyses and data evaluation are quite different depending on the area scale of the operation - national, state or local - and on the specific purposes for which the network is established. These differences in scope and purposes require evaluation. Pertinent points for consideration of this conference include interrelated questions such as the following:

1. How many stations are required for an adequate network operation on a National, State, or local basis, as a function of area only? Or of the size and number of urban areas? What are the criteria for selection of sampling sites? What statistical and meteorological assistance is needed in planning a network program?

2. To what extent does the specific purpose modify this scheme, i.e., what is the effect of a strictly monitoring program as compared to one set up for control purposes as well?

3. What pollutants should be measured? What laboratory support is essential to the successful operation of a sampling program?

4. What equipment is needed to do an adequate job of sampling? What is the role of automatic instruments in a monitoring program? Are mobile stations of any value in a sampling program?

5. Are data on suspended particulates and the organic and inorganic portions of particulates of equal importance in relation to air pollution? What sacrifices should be made in sensitivity in tests for metals in order to secure adequate organic measurements? Should sampling frequency be doubled using different types of filters to secure better overall results?

6. How about sampling for gases? Should there be equal emphasis on particulates? Or greater emphasis? At what point should particulate sampling be curtailed to emphasize gas sampling?

7. What degree of sensitivity in analytical methods is required relative to average yearly value or other values such as the 90% decile? For example, if the geometric mean is 10 units of pollutant per unit volume and the 90% decile is 20 units per cubic volume, what should be the desirable lowest detectable limit for the analytical procedure used?

8. Should samples be combined for detailed analyses (other than particulates, organics, and radioactivity) to optimize overall information for effort expended, i.e., is it more desirable to run detailed analyses, say, for two samples consisting of the heaviest quarterly sample and a quarterly composite than to analyze the 6 to 7 individual samples collected during the quarter and by so doing, increase the coverage threefold?

9. How long is "long enough" for monitoring a station to establish pollution levels? At what intervals should monitoring be reinstituted to establish trends? What sample averaging periods are important in network operations?

10. How about statistical analysis of data? How much is warranted in relation to objectives? What basic analyses are required or desirable?

11. What should be the procedure for release and publication of results? How much data should be released to the general public?

12. Of what use are the data obtained by the various types of networks? How can data be used in support of a control program?

13. What relations should exist among networks? How can interchange of information and ideas be accomplished?

14. What is the economic relationship of sampling materials and procedures to the purposes of the network, i.e., how should the budget be split between samplers and supplies, sample collecting operation, sample analysis, and data analysis and interpretation?

This list of questions representing the parameters in network operations could be expanded into more and more detail, and would become therby more and more interrelated. Hence, in speaking to the point of seminar objectives, I hardly hope for a multitude of clear-cut decisions to result from this meeting. Rather, I think our objectives, as I see them at least, could be stated about as follows:

1. First, that there be free and open discussions by everyone, in that only by this means will each of us, representing various groups with different objectives, come to understand and respect both our mutual and divergent problems. I know this is a trite statement of objectives, always included in the agenda, but for myself, one which I shall be paying particular attention to.

2. Secondly, that from these discussions will come some understanding of the need for modifying present procedures to meet the requirements of other groups. This, I think, is particularly important as we build up a back-log of data and look to ways and means of optimizing our efforts.

3. Finally, that these discussions will stimulate those of us, who are in these operations, to improve our procedures, and those of us, who wish to set up such networks, to return home perhaps both with more ideas and more enthusiasm.

CHAIRMAN TETZLAFF: Thank you, John.

Well, you have gotten quite a list of things that we would like to have discussed.

Do I have any questions or comments at this point?

How about the networks within the states? Do you feel that the type of sampling that's being done now is adequate? What pollutants should be measured? Do we have any comments on that?

MR. MUNROE: It would be helpful to me early in this conference if there should be some definition of what we mean by a network as distinguished from other types of air sampling; and, secondly, the meaning of air monitoring. What are we discussing when we talk about monitoring systems?

CHAIRMAN TETZLAFF: Mr. Munroe, of the New Jersey State Health Department is undoubtedly in a position to answer those questions himself, because he has given a lot of thought to them, but suppose we have someone else try to cover that subject.

Al Rihm, how about you trying it? You have been trying to set up a network in New York State, you have been thinking about it, and made pretty good progress. You have had all but the funds necessary, for most of the activity.

What do you consider is a definition of a network?

MR. RIHM: It is difficult to define it, I think. Many of us know what it is in our own minds, but a network, to my way of thinking, would be a great number of stations rather widely scattered around to get some overall appraisal of what the air pollution picture would be.

CHAIRMAN TETZLAFF: All right, that's a good start. Now, what do you mean by "widely scattered around"? It is certainly not a haphazard scattering; it is a scattering into very typical locations, that is, typical of all conditions within an area, isn't that right?

MR. RIHM: Yes.

CHAIRMAN TETZLAFF: And a scattering of what? It is certainly not a diverse bunch of sampling devices. They have to be fairly uniform and acceptable for their purpose.

How about the other point that Bill mentioned; what was that, Bill?

MR. MUNROE: The definition, or explanation of what we are talking about when we say monitoring.

CHAIRMAN TETZLAFF: Monitoring. All right, who will attempt that?

MR. GRUBER: With reference to definition of network, I wish to call attention to the limitations of the network as it is operated today. The network produces data on levels of particulate pollution at a limited number of stations and from a limited number of samples.

CHAIRMAN TETZLAFF: Well, that's fairly restrictive, isn't it, Charlie?

MR. GRUBER: When we talk about the network, without qualification, we give the impression that the whole range of contamination is included. Then overall comparisons are made on the basis of the numbers from the limited particulate sampling data.

CHAIRMAN TETZLAFF: The objective is not to get a measure of the conditions in Cincinnati to compare them with other communities? That isn't the objective of a network, is it?

MR GRUBER: But it is being done. You can't stop this comparison when the numbers are published.

CHAIRMAN TETZLAFF: All right, then, we have one point. Are we all agreed on that, that a network must produce figures which will permit some comparison of one area with another, either within that area or elswhere in the country?

Now, as to what we measure, we don't measure just anything that we know how to measure, we measure things that are of interest, or particular significance. I suppose ultimately we want those things that are significant in health effects, significant in the economics of air pollution, or in the aesthetics of air pollution.

Now, I don't know who is going to attempt to put this definition together for you, Bill, but I think we have touched on a lot of things. We want to sample in a uniform manner; we want to measure, as Charlie Gruber says, things which will permit a certain comparison of one area with another. We want to determine health effects.

Is there anything else that we ought to get into this definition? Harry?

MR. HANSON: It occurs to me that these purposes might be quite dynamic and that they will not be the same one year as they are another year.

For example, when the first national effort was begun, it was simply an effort to determine the general composition of the atmosphere over our major metropolitan areas. This was purpose number one at time number one.

But it seems to me that you might well have a series of purposes. As we achieve the first one, it can become a little more refined and better focused. We will move to another one, and so on as time goes on, so that we look at this thing as a dynamic purpose, rather than a static purpose.

CHAIRMAN TETZLAFF: And include other things as we go along, and as we know how to do them, and are able to do them economically.

This is very good. I hope we are not encroaching too much on Elbert Tabor's subject, which will describe our own network, and tell us about its history.

Any other comments?

MR. KOCH: I think there is one important thing, namely the absence of bias on what we are going to pick to sample. You also mention the term "significance."

How do we know it is significant? It reminds me somewhat of some of the older investigations we have done, say in water pollution, or food. We tried to focus down to one thing we knew, and tried to search for that, and, then, when it wasn't there, we started to scratch our head. But all the time these other tings were there.

I think we will have to do the same thing in the air pollution field. Perhaps today there is no establishment of relationship between incidence of disease and air pollution -- a particular disease, a particular pollutant. Perhaps tomorrow there will be, but how are we going to uncover it if we don't look for it?

CHAIRMAN TETZLAFF: That's a very good point. But there is a limit to what we can do, and I suppose we should have been measuring the amount of chemicals in cranberries, and so forth, all along, but until we know that it is worth doing, and can prove to the people that supply the funds that we are not just wasting effort, and money, why, we have to limit it to a certain extent.

Any other comments on that?

MR. MUNROE: Am I correct, then, in assuming that when we talk network or network monitoring, that we are distinguishing between the sampling of the homogeneous air mass as opposed to pinpoint type sampling where one particular source is under investigation, and the effort is one of determining how much one source is contributing. There is a distinct difference in the mechanics of these two sampling techniques.

CHAIRMAN TETZLAFF: Mass, in the sense of mass of numbers of sampling points?

MR. MUNROE: Mass in terms of ambient atmosphere.

CHAIRMAN TETZLAFF: Any other comments on that?

MR. STERN: A sampling station in a network which is under the influence of a specific local situation, would be poorly located for network operation. It is bad practice to have a sampling site under the influence of one specific local source, because it will mask the general area pollution you are attempting to measure.

CHAIRMAN TETZLAFF: Except if that source were pretty characteristic of the entire area.

MR. STERN: I was asked earlier to comment on what I saw abroad. One of the highlights was the intense activity in the city of Milan on the measurement of polynuclear hydrocarbons in the particulate content of the atmosphere, and the characterization therein of benzpyrene and the other presumed carcinogens. In London too, there is an intensified effort to characterize some of the more complex organics.

This is one of the areas into which we have been putting our greatest effort with network samples. A paper will be presented at the American Industrial Hygiene Association meeting next spring, giving the results of this characterization of the atmosphere of the United States with regard to polynuclear hydrocarbons.

CHAIRMAN TETZLAFF: Thank you, Arthur.

MR. SMITH: When the comment was made re the influence of a specific local source, I was running through our annual reports looking for some such data for another purpose. I think it is peculiar enough that our one sampling station which is located roughly 16 stories up was remarkably representative of the city average until we began to burn fuel in that specific building. Then it lost its close correlation with the average, and went up drastically, while other city averages were going down.

If your sampler is located in close juxta position to a source, then you are not representing the area any longer; you are representing the source.

CHAIRMAN TETZLAFF: That's very interesting. I am sure you all have some points that you can contribute to this discussion.

Unless there are some real important ones right now, I think we will proceed to the next formal presentation by Elbert Tabor, the Chief of our Air Sampling Network, who will discuss national networks in general.

NATIONAL NETWORKS

E. C. Tabor

MR. TABOR: It is my intention to briefly review the history and development of the National Air Sampling Network program, and to discuss the procedures used. I shall try to explain the philosophy back of our operation. Accomplishments will be mentioned and plans for the future will be presented. Discussions of data handling, analysis, and reporting will be presented by subsequent speakers.

The National Air Sampling Network started operations in 1953 to provide samples of atmospheric particulate matter for use in an investigation of the protein content of the air. It continued to function as part of this investigation until mid-1955 when the project was concluded.

During this time the Network expanded from 15 sampling stations at the end of 1953 to a maximum of 40 at the termination of the investigation.

Prior to the initiation of the Network program, a particulate sampler, capable of sampling at approximately 50 cfm, had been developed by Dr. Silverman of the Harvard School of Public Health. This sampler proved to be adequate for the collection of the samples of suspended particulate matter required for the study.

Intensive experimentation led finally to the development of a filter holder which would accomodate flat 8" x 10" filters.

Various media -- cellulose paper, crude cellulose pleated filters, glass wool, glass fiber sheets, and woven glass cloth -- were investigated, with the result that the now well-known glass fiber filter sheets were adopted for use.

This filter possessed highly desirable characteristics -- high filtering efficiency, easily freed of interfering materials, non-hygroscopic -- that could not be obtained in other filters.

Fortunately, at this time the glass fiber medium became commercially available at a reasonable cost. The filter material then available was supplied in rolls, was not uniform, and contained considerable organic matter, with the result that the first filter sheets had to be cut by hand, carefully inspected for defects, and finally heated in a muffle furnace to destroy all organic components.

Needless to say, the situation was greatly improved when flash fired sheets of fairly uniform thickness, and free of organic matter, became available in adequate quantities before the end of 1953.

This sampler-filter combination (Figure 1) could filter approximately 70,000 cubic feet of air in a 24-hour period, the actual volume varying according to the amount and nature of the atmospheric particulate matter. The samples, which in most cases weighed from 100-500 mg were quite adequate for the laboratory analyses to be performed.

In most communities at least two sampling sites were selected, one in the central business section and the other in either a residential or suburban area.

In a few communities, additional sampling stations were operated in commercial and/or other residential areas. Industrial areas were intentionally avoided. In most communities, sampling was done on a weekly basis, with the actual sampling day selected at the convenience of the cooperating agency. A few agencies, possessing greater resources, collected samples more frequently, either routinely or sporadically.

At first, the impetus for the establishment of sampling stations in a community originated at the Sanitary Engineering Center. However, after the Network had been operating for a short time, interest developed was such that requests were received from other communities for inclusion in the Network. In most cases, these communities were included as participants after the program had been explained and local arrangements for site location and sampler operation had been completed.

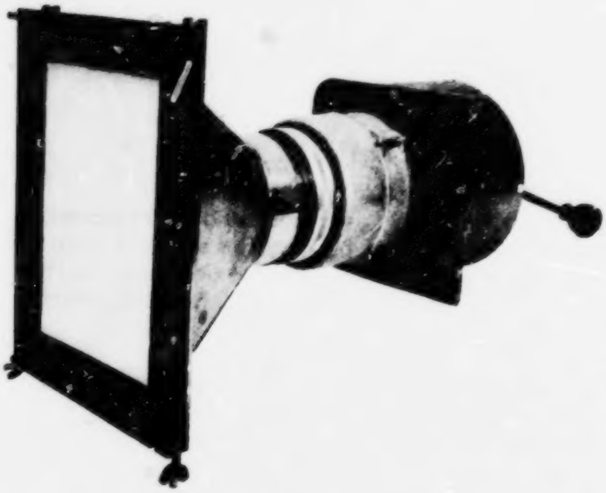

Figure 1. High Volume Air Sampler

The contributions made by these original participants in the early days of the Network operation must be acknowledged. They suffered with us in the development of samplers and shelters, selection of sampling sites, and collection of extra samples. They repaired, rebuilt, and otherwise kept the samplers running and the samples flowing into the laboratory.

The primary objective of the original project, previously mentioned, was the measurement of the protein content of atmospheric particulate matter. Since the protein content was to be related to the particulate matter, the determination of particulate levels had to be made.

This was easily done by first obtaining the weight of the sample and filter, subtracting the weight of the clean filter, then performing the necessary computations.

In the process of developing a method for the measurement of proteins, it was found that the particulate samples contained large amounts of organic materials which interfered in the chemical reactions involved.

Acetone showed the most promise as a solvent for the removal of these interfering organic materials; therefore it was adopted as the standard solvent for this purpose.

Since all samples required this preliminary extraction, we included the acetone soluble materials as a second measurement. At the same time, due to the general interest in environmental radioactivity, measurement of the gross radioactivity was begun by the Radiological Health Group of the Sanitary Engineering Center.

Thus, we became involved in making measurements which were of significance to atmospheric pollution. The protein determination was carried out on one half of each sample, with the other half being held in reserve as insurance.

Very few of these spare samples were actually used with the result that a considerable stock accumulated. The Kettering Laboratory of the University of Cincinnati became interested in our work, and indicated that they would like to analyze these extra samples for a variety of inorganic constituents.

Arrangements were made to provide the Kettering Laboratory with samples, and in a short time, analysis of samples for chlorides, fluorides, nitrates, sulfates, arsenic, beryllium, copper, sodium, iron, manganese, potassium, magnesium, strontium, lead, tin, vanadium, titanium, and silver was initiated.

With the passage of the Federal Air Pollution Research and Technical Assistance Act (Public Law 159 - 84th Congress) in July, 1955, and the subsequent organization of the Air Pollution Engineering Research Unit in the Sanitary Engineering Center, the air sampling program became a part of this group.

In mid-1955, the protein study was terminated and benzene adopted as a solvent for extraction of organic pollutants in place of acetone as the organic material obtained was more suitable for subsequent detailed analysis. Also, at this time, the Network group assumed sole responsibility for the analysis of all samples.

In late 1955, when the original Network was being converted into a national air quality surveillance network, the situation was as follows: approximately 60 sampling stations were being operated on very indefinite schedules in 40 communities representing relatively few states, additional requests were being received for inclusion in the Network and the analytical program was somewhat disorganized due to the unexpected growth of the Network and increase in the number of samples available for analysis.

It became obvious that a master plan for orderly program development would be necessary if the national needs were to be served.

In March, 1956, such a plan was established and the objectives of the Network clearly defined. This plan called for the establishment of one sampling station in each of 185 major population centers distributed among the 50 states, Puerto Rico, and the District of Columbia, and one nonurban station in each state and Puerto Rico (Figure 2).

The urban stations would be located in the central commercial or business areas, and the nonurban stations as remote as possible from urban influences on sea, gulf, and Great Lakes shores, and in desert, mountain, forest, or farmland areas.

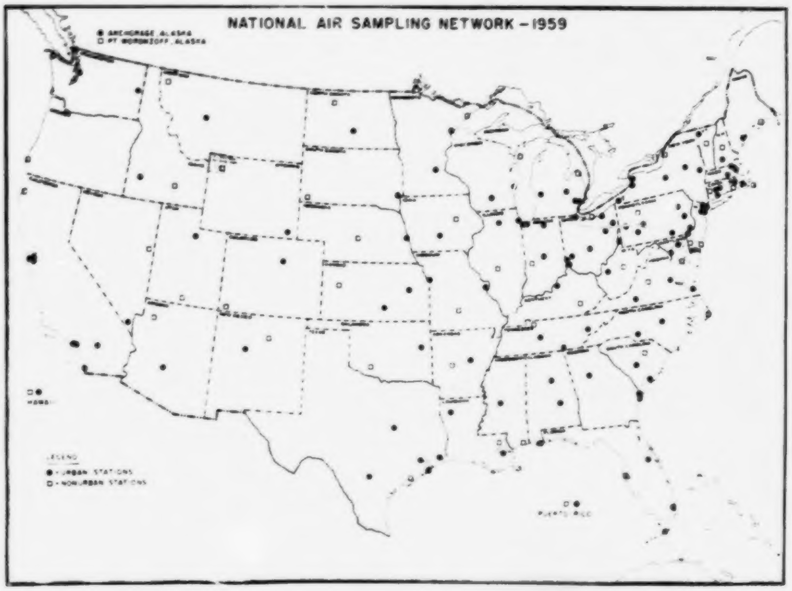

Figure 2. National Air Sampling Network

The Network was to operate on a calendar year basis with 70 urban and all nonurban stations operating every year, 36 urban stations on a biennial basis, and about 80 sampling triennially. The new plan was put into operation January 1, 1957, with all urban stations operating according to the plan. Activation of the nonurban stations proceeded slowly, with the result that only 24 of these stations were in operation during the year.

The objectives of the Network stated in the master plan were: to

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assemble basic data on the nature and extent of air pollution over the United States, to show trends with time, to show the influence of geography, topography, population, climate, industry, and other variables, and to provide data against which epidemiological findings might be correlated.

It must be noted that the Network was to be primarily concerned with investigating air pollution on a national basis, although it was realized that the data obtained would also be of value locally. Also, it was not intended to attempt to emphasize or point out the differences in air pollution levels in different communities.

The most difficult decision relative to changes in the Network involved use of only one sampling site per city, a decision reluctantly taken in order to obtain national coverage within existing budget limitations. We still feel that, where possible, analysis by state and local laboratories of samples from more than one sampling site in each major city should be carried out. Such local data are needed for fullest exploitation of the data from the local National Air Sampling Network station.

Where there are multiple sampling stations in one city, individual station differences are to be expected. Rises and falls in pollutant levels at various stations tend to be in phase with changes in the diffusional scale; changes from day to day at each site are large compared to site-to-site variations at any given instant of time. Therefore, a single Network site gives worthwhile information even though another site could possibly have somewhat larger or smaller concentrations.

In order to secure the desired national coverage within the budget, it was decided to switch from weekly to biweekly sampling, and to select the biweekly sampling period on a completely random basis.

An individual sample from a station is almost meaningless. Samples have meaning only when a sufficient number have been obtained, in such a wide variety of meteorological conditions that a representative range from minimum to maximum diffusion conditions are sampled.

A more accurate sampling method would be to predict diffusion a day ahead and sample the meteorological range by obtaining a few samples representing each interval between very stable atmosphere with a minimum of diffusion of pollution away from the ground level to a highly turbulent atmosphere with a maximum of movement of ground level pollution vertically and laterally.

We cannot do this because we do not have, at each of over a hundred stations, the equipment, personnel, and know-how for such prediction. An alternative would be to sample daily for 365 days a year and divide the samples on the basis of known meteorological conditions into diffusion intervals.

The data would then be analyzed as a grouped or stratified sample. This was done in our Louisville and Nashville studies, but we cannot ask volunteer cooperators to do likewise over the nation.

The other alternative, which we have adopted for the Network, is a completely randomized sampling schedule in which we expect by chance to sample all the major ranges of the diffusional scale in successive samples at a given station.

Prior to 1957, all samplers were operated in a horizontal position, and protected by a wide variety of shelters constructed by the local operator. Under these conditions they were subjected to the influence of the wind and rain.

Effective at the start of 1957, sampling procedure was standardized with all samplers being operated in a vertical position and housed in a standard shelter (Figure 3)

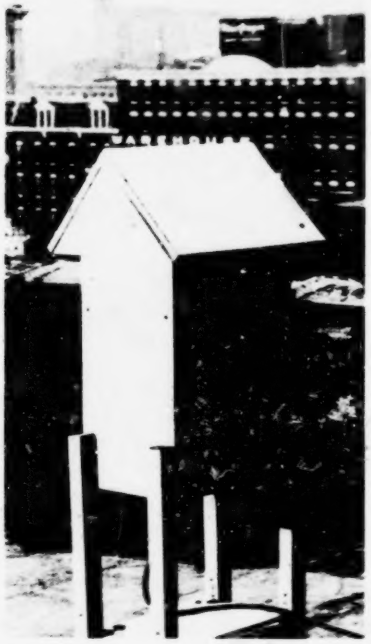

Figure 3. Vertical Shelter

which also doubled as a shipping container. This present shelter, which provides excellent protection against precipitation, also limits the action of the wind on the sampler. No wind can blow directly across the filter and all air passing through the filter enters the space above the sampler in an upward direction, thereby limiting the size of particulates collected.

The sampler itself has been improved and the screw-on filter holder developed by the Network has been adopted as standard by sampler manufacturers.

The original sampler possessed several undesirable characteristics: thin sheet metal parts, rubber gaskets subject to deterioration; motor and brush replacement were complicated and time consuming. To eliminate these weaknesses, an improved sampler, using a different blower, has been developed. This new sampler, which performs basically the same as the other, is more sturdy and brushes and motors are replaced easily in a few minutes.

The major criticism of the sampler based on the decrease in air flow caused by the build-up of particulate matter on the filter has now been overcome. This is not a serious problem when sampling in nonurban areas and in cities with relatively low particulate levels, but has been a cause for concern when sampling in communities with high particulate levels, or with particulates of such nature that the filters plug rapidly. We now have a flow regulator that will provide for a practically constant air flow, over a 24-hour period, in the range 35-40 cfm, even under the most extreme conditions. This regulator was designed to fit the standard sampler-filter holder without modification, and is relatively inexpensive.

Effective the first of next year regulators will be installed in samplers located in cities where the greatest drop in air flow occurs. Use of these regulators will result in more reliable air flow measurements and uniform sampling rates over the whole sampling period, thereby increasing the accuracy of the air quality measurements.

The glass fiber filters remain the most useful for the collection of particulate matter. In spite of inconveniences caused by changes in composition, and confusion due to the introduction of new products, these filters will probably be accepted as standard for some time to come.

Particulate matter, organic materials, radioactivity, sulfates, and nitrates may be adequately determined in samples collected on these filters. The usefulness of this filter for the collection of samples for the determination of many metals, fluorides, chlorides, etc., is somewhat limited due to interference of trace elements in the filters and the difficulty encountered in removing the sample material from the filter.

Cellulose filters, such as Whatman #41, are suitable for more accurate measurement of the metals, but in many situations, the sampling period cannot exceed 8 hours due to rapid increase in resistance to air flow. Samples collected on cellulose filters can only be weighed under carefully controlled conditions and are not suitable for measurement of organic pollutants or radioactivity. A sample covering a 24-hour period can be collected if the sampler is controlled by a clock which limits sampler operation to 10 minutes out of each 30 minutes of the sampling period.

We have found that 8" x 10" millipore filters are of limited use as the resistance increases so rapidly that the capacity of the high volume sampler is exceeded in a few hours.

For the collection of larger amounts of particulate matter the use of the 8" x 10" millipore filter with a positive displacement carbon vane pump having a sampling rate of 12-14 cfm has proved to be very satisfactory. The chief disadvantage lies in the weight of the sampler which is too great for easy portability.

Perhaps at this point it will be well to review the particulate pollutants that have been and are being measured, and the reasons for measuring them.

From the beginning a measurement of suspended particulates, organics, and B-radioactivity has been made. There should be no question concerning the desirability of continuing to measure these pollutants.

Particulate levels are easily determined and are a partial index of total pollution levels. Specific health effects may be related either to the gross organics or to individual compounds occurring in the organic fraction; also, there is considerable variation in quantity as well as in the nature of these organic materials. Materials removed in making these determinations can be used for the identification and measurement of individual compounds or groups of compounds.

In this nuclear age, constant monitoring for atmospheric radioactivity has assumed considerable importance. The radioactivity data provided by the Network is, in many cases, the only such data available to a community, and this alone provides justification for continuing to carry out this measurement.

The non-metals -- chlorides, fluorides, nitrates, and sulfates -- have been determined on many samples. Chlorides cannot be measured using samples collected on glass fiber filters, manufactured since mid-1955, due to the high chloride content of these filters. No fluoride determinations have been made since the Kettering Laboratory terminated its participation in the project, due to the complexity of the analytical procedure and the large investment of manpower needed to perform the analyses. The analysis of samples for nitrates and sulfates is being continued due to the possible relation between levels of these pollutants and various combustion processes, and as an index of the corrosive action of the atmosphere.

A total of 23 metals has been determined at various times. Some, such as sodium, potassium, magnesium, and strontium were investigated simply because it could be easily done while performing other analyses; however, since they are of doubtful significance, as far as air pollution is concerned, they are no longer measured. The determination of arsenic has been discontinued due to the time required to do the work; the measurement of silver is no longer attempted due to low concentrations in the air; while the high barium content of the filters renders this determination unsuitable.

The 16 metals currently being measured have been mentioned as being either of significance or potential significance with regards to health.

Questions regarding the accuracy, dependability, suitability, and sensitivity of analytical methods frequently arise. These questions can only be answered by critically examining the purpose of the investigation, the use to be made of the data, the amount of effort and money to be spent on obtaining the results.

For instance, if we wish to relate the level of atmospheric lead to the amount of automobile traffic, we would require a more sensitive and accurate analytical method than would be needed if we are attempting to get a gross measurement of general atmospheric lead levels.

To obtain great accuracy and sensitivity requires a much greater expenditure of manpower, thereby limiting the number of analyses that can be performed.

Why is great sensitivity needed in the measurement of sulfates, with an average urban level for 1953-1957 of 13.9, $\mu g/m^3$? A sensitivity of .1 $\mu g/m^3$ is easily achieved but such a low level rarely occurs; therefore, it would appear that here we are going to an extreme which has little justification. In the case of metals such as Be, Bi, Cd, etc., where the levels are quite low, we naturally strive for maximum sensitivity.

Of the methods currently in use by the National Air Sampling Network, those for suspended particulates, organics, B-radioactivity, nitrates and sulfates, are fully satisfactory as applied to samples collected on the glass fiber filters.

A somewhat different situation exists in the determination of the metals. Here we have two problems: 1) presence of trace metals in the filters and 2) variable efficiency in removal of the inorganic materials prior to performing the analysis.

For practically all urban samples, the interference of the filter itself is of no significance, nor is it a serious problem for most nonurban samples.

It could be of concern if it is desired to measure very small amounts of a metal with a high degree of accuracy. The variable efficiency in the recovery of the inorganics from the filter can affect the results of the analysis.

It must be pointed out that the only effect would be lower values due to low percentage removal, as this could in no way give higher values. On the basis of a limited amount of work done by the New York State Health Department laboratories, it appears that recoveries of Sb, Cu, Mn, Ni, V, are good; Cr, Co, Fe, Pb, Sn, are fair; and Be, Bi, Cd, Ti, Mo are questionable or poor.

We do not believe that the above problem invalidates our results, provided we recognize the limitations of the data and use extreme care in the analysis, comparison and interpretation of results. Relatively speaking, we think our methods are sufficiently accurate to give a good indication of general pollution levels. We make no claim that these methods are adequate for any and all studies relative to a variety of air pollution problems.

An improvement in the measurement of the metals can only be accomplished by the adoption of a more suitable filter and the collection of special samples to be used for this purpose. We have done preliminary work on this problem by analyzing samples collected on Whatman cellulose filters. These filters do not have the efficiency of the glass fiber filters; samples collected on them are difficult to weigh, and sampling must be limited to around 600-800 m^3 per 24 hours instead of the usual 2,000 or so.

Measurable amounts of trace metals are present in the filters, but they can be used on the present sampler and appear to be generally applicable to this particular problem.

By ashing the filter and sample and adding the powdered sample directly to the spectrograph electrode, the problem of recovery of sample from the filter has been solved. Corrections can be made for the filter blank.

Effective January 1, 1960, special sampling, using the cellulose filter, will be conducted in parallel with the usual sampler and filter, at a few selected stations in order to provide material for a thorough investigation of this analytical problem.

In the early days, an attempt was made to analyze all samples received, but as the Network expanded, this became impossible with the result that, as part of the master plan, an analytical scheme was developed to suit the capabilities of the Network laboratory.

Stations were placed in one of three analytical categories; all samples were to be analyzed for suspended particulates, organics and radioactivity; category three samples received only this treatment, category two samples were also analyzed for nonmetals, and category one samples were analyzed for metals and nonmetals.

This scheme was followed through 1958. After reviewing the results of this program, it seemed desirable to make a change as, under this plan, we were obtaining information on the inorganic pollutant levels from only a relatively small proportion of the stations and it did not seem desirable to repeat such measurements for the same group of cities when we had no data at all from many areas.

For each station, under the present plan, we analyze the heaviest sample collected in each quarter, and a composite of all samples collected in each quarter for a total of 8 analyses instead of the usual 26.

This is being done for all stations for which inorganic data are not available for samples collected in the years 1957-1959. The results of this analytical program will not be fully known until the data obtained from a large number of stations can be evaluated.

It has been recognized from the beginning that an adequate assessment of air quality could not be made without including the determination of gaseous pollutant levels in the program.

A method for the collection of gaseous pollutants, if it is to be included in an extensive Network operation, must be relatively inexpensive and require a minimum of the cooperators' time.

Existing methods for the non-specific collection and measurement of gaseous pollutants do not meet the above criteria and there seems little chance that a suitable non-specific technique will be developed in the near future.

Because of the existing need for information on levels of gaseous pollutants, the decision was made to undertake the development of sampling and analytical procedures for the measurement of the more common gaseous pollutants.

Since much previous work had been done along these lines, it appears, on the surface at least, that all that was required was the modification of existing techniques with a minimum of work on new developments.

The first step was the development of a sampler with the following characteristics: 1) it should be simple to operate, 2) must be portable, 3) should be capable of sampling for several different gases, 4) all samplers should operate at the same temperature regardless of location, 5) air flow should be constant, 6) must use a lightweight inexpensive pump, and 7) must be capable of sampling for a 24-hour period.

Such a sampler was developed in cooperation with the Instrumentation Group of Air Pollution Engineering Research. It can sample for five gases at a constant rate of 100 cc/min., at a constant temperature, for 24 hours (Figure 4).

To start the sampling operation, the operator has only to remove the glass plugs from the five sampling tubes which are provided, connect the sampling tubes, and turn on the pump and heater

At the end of the sampling period, the pump and heater are turned off, the sampling tubes disconnected, the glass plugs inserted and the sample tubes mailed in a special container to the laboratory. The whole operation requires approximately the same amount of time as used for the collection of a particulate sample.

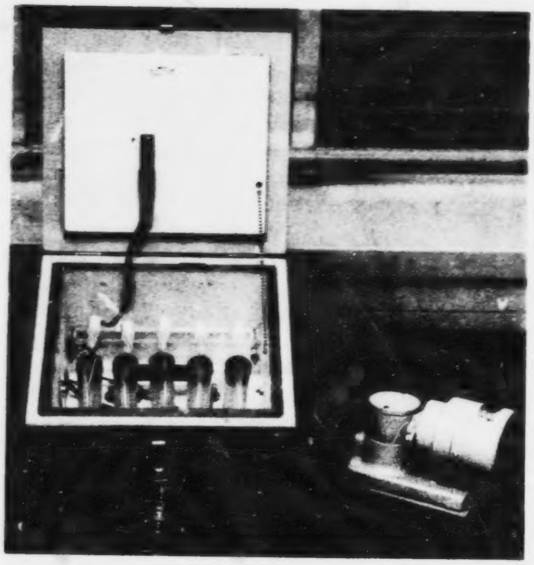

Figure 4

The major requirements for the collecting solution were: 1) the solution must be stable before as well as after sample collection, 2) must be suitable for the measurement of a specific gas by a method capable of adaption to automation.

The West method for the collection and determination of sulfur dioxide has been fully satisfactory. For the oxides of nitrogen, the method of Jacobs appears to be adequate. The alkaline iodide method was used at first for the estimation of oxidants, but it proved to be unsuitable due to instability.

The neutral iodide method is being investigated currently. The phenolphthalin method for oxidants does not possess the necessary stability for use in this procedure.

So far no decision has been made regarding the other gases to be measured. It seemed best to concentrate on the development of a practical sampler and suitable procedures for the three gases mentioned above before other gases were to receive consideration.

Eventually, we hope to have procedures for several other gases so that the sampling program may be tailored to meet the needs of the individual community.

We have had 18 samplers undergoing preliminary tests in the field. Several weaknesses have been uncovered which require modification of the sampler. These modifications are currently underway, and should be completed by the end of the year.

To date the results for sulfur dioxide and oxides of nitrogen have been encouraging. The methods used are very sensitive and permit the measurement of low concentrations of these pollutants. The minimum detectable quantity for SO_2 is .005 ppm, and for N oxides, .002 ppm.

During this initial testing period few high levels have been detected, most results falling below .1 ppm. With the onset of the heating season, we can anticipate the occurrence of higher concentrations of SO_2 in the coal burning communities.

This method, based on 24-hour sampling periods, will not show short time peak levels but will provide abundant data on 24-hour average levels. Sampling for peaks can only be accomplished efficiently by the use of automatic analyzers.

Obviously, it would be impossible to set up a network of 125 sampling stations equipped with such analyzers costing in the $4000 - $5000 range.

Information on the nature and extent of air pollution can also be obtained by the analysis of precipitation. A large European network is in existence which has as a major objective the measurement of amounts of various nutrient materials added to the soil by precipitation.

Similar work in this country was done cooperatively by the Weather Bureau and the Air Force Cambridge Research Laboratory in 1955-56. The interest was primarily in the meteorological aspects of precipitation composition.

Earlier this year plans were made for the reactivation of the precipitation chemistry project with the work to be done cooperatively by the Weather Bureau group assigned to Air Pollution Engineering Research and the National Air Sampling Network. The plans for 1960 call for the operation of 30 of the stations (Figure 5) that participated in the original study and the analysis of samples following the procedure used in the former study. The objectives for 1960 are to: 1) compare results with those obtained in the previous study, 2) determine what, if any, changes have to be made in the collecting procedure, 3) develop suitable analytical procedures adapted to automation to permit efficient analysis of large numbers of samples, 4) development of plans and equipment for the investigation of air pollution.

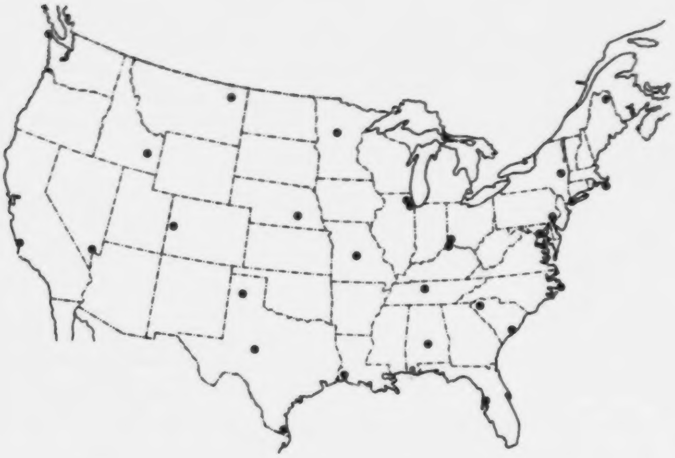

Figure 5. National Precipitation Network

Monthly composite samples of precipitation are obtained by means of a collector which is open only when precipitation occurs, thereby preventing the collection of "fall out" during periods when there is no precipitation.

These samples are then shipped to the network laboratories for analysis. The present collector is manually operated and can accomodate only .7 in. of rain without loss or change of collection bottle.

To date the collection efficiency at most stations has been rather poor for understandable reasons. This was the first problem to be solved when the new project was started.

Modified collectors, devised by the Meteorology Unit staff, will either be operated manually or automatically and have a capacity of about 14 in. of precipitation. All stations should be equipped with these new collectors by the first of the year, and we expect that collection efficiency will show a marked improvement.

Most of the collectors, at present, are located at first class weather stations which are attended 24 hours a day. Development of the automatic collector will permit sample collection at unattended sites so that in the future it will be possible to have a precipitation collector operating alongside the Network particulate sampler in selected urban areas.

Present plans call for the analysis of monthly samples for total solids, gross β-radioactivity, ammonia, calcium, potassium, sodium, chloride, nitrate, sulfates, and pH. This will provide data comparable to that obtained in the earlier study.

After the 1960 project is well under way and running smoothly, plans will be developed for the establishment of sampling stations in a limited number of urban areas. Some time will also be taken to investigate other analytical procedures which may provide useful information.

We recognize precipitation analysis as another method of collecting data which will assist us in answering questions pertaining to air pollution, and believe that we are justified in carrying out a preliminary study to determine both the feasibility and usefulness of this approach, particularly in the light of ease of sample collection and analysis.

What we have learned regarding the operation of an air sampling network: the most important conclusion we have reached as a result of our experience is that adequate planning should be completed before a single sample is collected.

What are the objectives of the program? What pollutants should be collected and measured? What sampling procedures should be used? Where will samples be collected? How are sampling sites selected? How will the data be used?

How will the findings be released to the public? What are the criteria for the selection of urban communities for participation? Nonurban locations?

How many sampling stations should be established in a city? How does the geography and topography of a city influence site selection? What analytical procedures are to be used? Is it necessary to develop new analytical methods? What accuracy and sensitivity are required? Can the analyses be performed economically? How will the analytical data be handled? What statistical analyses will be performed? Will it be more feasible to do these analyses manually or should consideration be given to the use of electronic computers?

After these and many other related questions have been considered, the answers should be re-examined to determine their appropriateness one, two, five, or ten years later. A sufficient number of unanticipated questions and problems will usually arise later to keep one occupied without intentionally leaving some of the original questions unanswered.

Eternal vigilance must be the watchword whether one or a hundred stations are in operation. Samplers are notably tempermental and require constant attention. Mistakes can be made in setting up schedules, samplers can be stolen, supplies may sometimes be sent to the wrong station, and, in general, if something can go awry it is just a question of time until it will.

Another most important thing we have learned is of the willingness of hundreds of people to assist in the conduct of a program which at first may appear only remotely related to their official duties. The responsibility for the operation and the maintenance of the samplers has been graciously accepted and the cooperation has been near perfect.

The few failures we have experienced have not been due to individuals but to conditions over which no one could reasonably be expected to exercise control.

It is well to take stock at regular intervals to determine what is being accomplished. In the few years the Network has been in existence several worthwhile contributions have been made:

Considerable interest has been developed in large numbers of communities as a result of their participation in the Network Program. Network participation has provided information which has been useful in supporting air pollution activities in many communities.

Large amounts of new data have been obtained on the nature and extent of air pollution over the United States. It is estimated that approximately 25, 000 samples have been collected at 250 sampling stations since the Network started to operate in 1953.

Five years ago, about the only air quality data available were dustfall and AISI sampler data from several cities, scattered data on a few gaseous pollutants from a few cities, and more extensive data from Los Angeles County and Detroit.

In addition to data on suspended particulate levels, the Network has collected much data from a large number of communities regarding the chemical composition -- organic as well as inorganic -- of the particulate matter. For the first time, detailed air quality data are available for examination by the medical profession.

As a result of statistical studies of Network data, a method for the evaluation of the air pollution for a given sampling site has been developed. This evaluation technique should prove to be of great value in defining potential problem areas. It is true that, at present, we do not have sufficient information to enable us to detect trends in air pollution, but in another year or two it will be possible to make preliminary statistical studies on the best procedure to be used in the establishment of trends.

As a result of a study conducted during the steel strike in the summer of 1956, we were able to quantitatively demonstrate the contribution of a single heavy industry to local air pollution. This was the first time that detailed measurements of this nature had been reported.

A two-year study of the carcinogenicity of particulate pollutants from nine Network stations (Atlanta, Birmingham, Cincinnati, Detroit, Los Angeles, Nashville, New Orleans, Philadelphia, and San Francisco) has just been completed.

The participating agencies collected large amounts of particulate material, the Network laboratory staff performed the necessary separations and analyses, and the Environmental Cancer Unit of the National Cancer Institute and the Department of Pathology of the University of Southern California performed the animal experiments. This was the first study of this nature ever conducted and the results will be published next year.

Several Network agencies have cooperated in a study of methods for forecasting high levels of air pollution initiated by the Meteorological Unit and the National Air Sampling Network in 1957. This project requires the collection of extra samples during periods when certain meterological conditions conducive to an increase in pollutant levels occur.

Examination of data obtained in 1957-1958 demonstrated that it is feasible to use forecasts of meteorological phenomena to delineate periods of high pollution potential for a large area. A larger number of stations are involved from September 1 through November 30 this year as the program has been expanded to cover most of the states east of the Rocky Mountains. This project appears to be showing an excellent return on the original investment.

Numerous papers and reports, based on the Network operation, have been published. Of these, seven presented information on individual pollutant levels; one covered the 1956 steel strike; three were concerned with data processing and analysis; preliminary results of the forecasting project were discussed in a single paper; and five were of a general nature.

A report containing summaries of all Network data for 1953 through 195? was published last year (Air Pollution Measurements of the National Air Sampling Network). One chapter in a forthcoming AIHA Air Pollution Manual is based on National Air Sampling Network data.

Last, but not least, the Network has offered encouragement in every possible way to state and local agencies in setting up and operating a variety of sampling operations.

We have loaned equipment and filters, analyzed samples, offered advice when requested, and assisted in setting up sampling schedules and data handling procedures. Many sampling programs are being conducted in such a manner that their data either have been or can be incorporated into the National Network data summaries.

Our computer programs are available for use by any agency having sufficient data to profit by their use. Assistance in the statistical analysis of data can also be provided.

The Network will be operated as long as it is productive. Several years of operation will be necessary before enough information has been obtained to predict trends in air pollution levels. The plan of operation may be modified to meet future needs. We are not committed to the indefinite operation of all stations.

It is hoped that the full responsibility for the operation of many stations and the analysis of samples will be assumed either by the community or by the state. We will continue to encourage the establishment of state and local sampling and monitoring programs.

Sampling techniques may be modified to meet specific needs; several methods have not yet been explored. There is even a possibility that sampling frequency and scheduling could be changed after a critical examination of past results.

More and more emphasis will be placed on the gaseous sampling program. There will be an expansion of this operation from time to time, until all stations sample for both gases and particulates. The next move is to increase the number of gases to be measured.

This will follow as soon as we have placed the sampling on a sound basis. It may be possible to have the analyses performed locally. This will be pursued as it could well be a means of obtaining more data, and at the same time, would encourage and assist the local cooperator in conducting a sampling program.

The State of California and the Bay Area Air Pollution Control District are currently operating an oxidant monitoring network, with the analyses being performed by the local station operator. The use of sequential samplers for shorter sampling periods will be considered after sufficient data on average gaseous pollutant levels have been accumulated.

The investigation of precipitation analyses as a technique for obtaining data on urban air pollution will be carried out with pilot studies being undertaken in the latter part of 1960. Plans for this activity will be formulated with due regard for statistically sound procedures and standard meteorological practices.

We plan to keep the Network operation flexible in regard to sampling and analysis in order to optimize the information obtainable. Changes will be made to reflect evaluation and interpretation of data collected in the Network operation itself, but hopefully in the light of socio-economic conditions intimately related to pollution conditions.

We do not expect to find all of the answers in one, three, five, or even ten years, but with each added year's operation of the network, we do expect to make important contributions to a better understanding of air pollution over the United States.

CHAIRMAN TETZLAFF: Thank you, Elbert.

We are running a little overtime right now, but I think we should have some discussion of the subject.

Are there any questions on the genesis of the Air Sampling Network.

MR. CHALKER: I notice that you always talked about 24 hours. I think a great deal could be learned here by distinguishing between night and day samples. We suspect perhaps that dispersion parameters vary as much between day and night as they do between the seasonal extremes. Also, I think much could be learned by using an even shorter time scale of sampling. You mentioned the heating season, the increase in soot and so forth, and SO_2.

In regard to the heating season my furnace doesn't run much in the daytime, for example, but it runs all night. If commonplace, I wonder if this might be significant. It might be an interesting point to evaluate the possible diurnal variation of some of these pollutants.

The other point was this. If there is a medical relationship, it might very well involve the particle size of these materials. I am sure, this is not a new thought, but has any analysis been made of these particulate samples along the line of characterizing them for particle size distribution?

CHAIRMAN TETZLAFF: I am sure Mr. Tabor would like to have much more frequent examination of the samplers and removal of the filters. Perhaps you would like to add something to that, Elbert.

MR. TABOR: Our objective is to study air pollution over the country as a whole, not as a local problem. I think one reason why we don't get too much involved in the short-time samples is that that is bordering on local studies.

Admittedly we would get a good deal of useful information, but again we are faced with the problem of a certain capacity for handling samples; if we collect two samples instead of one, then we could have one-half the number of communities, rather than the existing number.

This matter of diurnal variations comes up from time to time. No doubt it will receive more consideration in the future.

But I think first of all we want to make some progress on accomplishing our present objective.

If any local agency wishes to do that type of sampling, we would be very happy to have them use the equipment and we will provide the filters, if they want to collect eight-hour samples, or 12-hour samples.

MR. GRUBER: If the objective is to get long-range trends, would a continuous sample over a 30-day period, give this information better than today's 2 samples per month?

MR. TABOR: Well, it is very true that such samples can be used to get monthly averages. We have had only a limited amount of experience in collecting these. We are doing continuous sampling in nine cities, and in seven of the nine, we can get monthly samples. In two we cannot, because of the nature of the particulate matter.

MR. SMITH: Is it that, or because of the location of the sampler?

MR. TABOR: I am sure it is the particulate matter. It couldn't be otherwise -- the source is so general that it is directly related to the high organic content of the particulate matter. I don't think there is any question about that.

CHAIRMAN TETZLAFF: I think the limitations have been imposed largely by just a lack of equipment and personnel and funds for this activity. We are doing, we believe, what is feasible with the amount available.

MR. STERN: Some of the kinds of studies that Mr. Tabor and Mr. Gruber mentioned are being carried on as research projects in connection with detailed studies of air pollution in Nashville and Louisville.

Although they are not incorporated in the National Air Sampling Network these matters are not being ignored but are being aggressively studied by other groups in our program. The meteorological group is making studies of this nature, and so is the group charged with the responsibility for running local studies.

CHAIRMAN TETZLAFF: Yes, thank you. The Nashville study, of course, was intended to determine by means of very exhaustive studies of the air pollution in Nashville what minimum sampling can be performed to provide an adequate picture of the pollution in the community and the possible connection with health effects in the community.

That report will be out in time, and should be of interest in this connection.

I know that a number of you have been quite outspoken about the need for doing something with other filters which will not mask the metals in the samples, and I am sure we will be able to get into that with your cooperation.

Mention was also made of some papers on the network which have been issued in the past. I know that we would be only too glad to let you have copies of those papers, and as a matter of fact, papers on any other aspect of the air pollution engineering research effort.

I think that's about all, unless there are other questions.

Al Rihm, do you have one?

MR. RIHM: Elbert mentioned that you plan to use these rate controllers, on the network high-volume samplers and that they weren't particularly important on the non-urban sampling stations, but on the urban sampling stations.

At what drop in flow rate does this become important?

MR. TABOR: We have this situation, at the start of the sampling period, we may have an air flow of 60 cubic feet per minute and at the end of 24 hours, it may have dropped down to 30. Now, we recognize the fact that most of that drop could take place in the first part of the sampling period, or it may have occurred in the middle, or towards the end. The only thing we have been able to do is to take an average of the two readings, the beginning reading and the final reading.

There wasn't anything we could do about it, and this has been recognized a good long time.

Now, in the non urban stations, we rarely get a significant drop. That is, it may be a couple of cfm, which is of no significance in the overall sampling.

And in some urban areas, we may have the same situation. The thing we want to do is to remedy this situation in the urban areas where we have this large drop in air flow. Now, this flow controller will limit the air flow in the first place. It will sample at a lower rate, but it will be quite constant over the full 24-hour period.

This does two things: this gives us a rather straight line air sampling rate, and it permits us to sample at a uniform rate over the 24 hours, which we have not been able to do previously.

Does this answer your question?

MR. RIHM: Well, not quite.

I wanted to know if you had established any figure, let's say when the flow rate drops five cubic feet, that this was important from there on.

MR. TABOR: Well, we think in terms of about ten percent, that we would be very happy if we could keep an air flow control so that we know that we are not off more than about ten percent.

I think that's fairly reasonable, and that is our target, anyway.

MR. RIHM: I would like to add one more thing, and this is in reference to the spectrographic work. You said that some of the extractions were fair to poor. I would like to also get across the point that the extraction efficiencies for some metals may vary extremely; even from the same sampling site on two consecutive days. One day you may be able to extract 85 percent of a metal from the filter, and the next day only 15 percent.

MR. TABOR: I tried to strike a rough average of your data, and obviously, since it did not cover a very large number of samples and since we had these variations, I just had to make some crude approximations.

MR. RIHM: I am not criticizing; I am just adding that they are extremely variable.

MR. TABOR: That is quite true.

MR. STOCKMAN: Elbert, I would like to inquire as to the real objective of collecting the data on radioactivity that you mentioned, and if you are straining your resources to do it, and if we are learning something that we don't have from other sources.

In other words, my point being that if it is any burden, could we better put this effort to some other use?

MR. TABOR: From our standpoint, it is rather inexpensive, and we look upon this not as making an air pollution measurement, but providing some information that is not available to a good many local agencies.

The radiological health program -- or the Division of Rad Health provides the counting room facilities and the equipment for doing that. We have on our payroll one aide that does the counting, so actually it does not cost us very much.

And in view of our experience in the past, I think we will continue to make this measurement, because we have had several requests where we were able to come through with this type of data and no other agency has it.

It is an incidental thing that is not a very large part of the operation, and no one has recommended that we discontinue it.

CHAIRMAN TETZLAFF: We had one recommendation just now. The consensus seems to be, however, that it is of some use and to that extent I think we should continue it.

Are there any other questions?

MR. MUNROE: Just one more. I became somewhat concerned when it was mentioned that some of these samples have been submitted to the National Cancer Institute for pathological work. I can visualize that perhaps we might get into another cranberry type situation. One might expect that a number of rats, if treated with just the gross sample as collected, might show evidence of malignant tumors.

What is going to happen if data of this type is released without very careful qualification?

CHAIRMAN TETZLAFF: Well, first of all, there isn't any haphazard checking of samples for carcinogenicity. These samples that Elbert mentioned were samples from communities that were told about this special study and agreed to it.

The work is being done mainly by the National Cancer Institute, and any release will only be in collaboration with the medical people who are working -- who set the study up.

There isn't any other sampling of that type, or checking of that type being done on a network. We realize that we must have your cooperation in this; you must know what we are going to be doing with the samples. As a matter of fact, later in the seminar, we are going to have some discussion of the use to be made of samples, and I think we will have some better understanding of this as we go along.

That probably doesn't answer your question, Ray. I don't know just how they are going about to release it.

Any other questions? Since there are no further questions we will now adjourn and reassemble into groups for the tour of the network laboratories.

AFTERNOON SESSION

CHAIRMAN ARCH: May I have your attention, gentlemen.

I wish to thank Mr. Hanson for singling me out in his opening remarks. I represent all the members of APCA who are present for this session, and our membership -- a great many of you gentlemen, of course, are members of APCA.

Our membership is highly involved with, greatly concerned with, and interested in, the National Air Sampling Network. I myself think back to some of the remarks that Mr. Tabor mentioned about the personnel who operate the stations. I have had the experience as a supervisor of some technicial help who didn't care whether school let out or not as far as the sampling network we operated around Niagara Falls, New York was concerned. Unless I personally went up on the roof of the City Hall during a bitter snow storm, or a blustery wind storm, the samplers didn't get changed periodically as they should have.

I know firsthand what some of the problems are in actually operating the National Air Sampling Network, also the State Sampling Networks. Al Rihm, Charles Maneri of New York State, and I have had a great many conferences on how to get the local agencies to take sufficient interest and carry the ball from where it has been left by both the national and state agencies.

This afternoon you have a lengthy panel to start off the afternoon program with, and I will just mention one matter. I carried on the plane with me a few copies of the latest APCA Journal, which has a different color this month that it has prior to this particular issue. We have gone over to red because we save $50 a month in using the predominant color scheme of the advertiser on the cover section.

The important thing, however, is that in this issue, the first papers which were presented at Los Angeles are now beginning to appear, and one of the outstanding papers of the meeting was the one by Charles Zimmer, Elbert Tabor and Arthur Stern on particulate pollutants in the air of the United States. It is an excellent paper.

In addition to that, to satisfy some of the people who don't agree with all of the ideas presented in the paper, a commentary by Walter A. Quebedeaux, of the Harris County Health Department, on why he feels some of the things in the paper were not according to Hoyle.

I brought some extra copies with me. I will tuck into these copies an invitation to membership in APCA, and I trust that the non-members of APCA will help themselves, and then give some consideration to the application blank.

The panel, which will commence now, and continue for the next hour and 50 minutes, is to be chaired by Robert L. Stockman, who is Chief of the Air Pollution Control Section of the State of Washington, and he has several experts who have first-hand knowledge of the problems involved in operating state networks, local networks, and the national network.

PANEL DISCUSSION

STATE AND LOCAL NETWORKS

Robert L. Stockman, Moderator

MR. STOCKMAN: It is indeed a pleasure to serve as the moderator for the panel discussion on "State and Local Networks". It is a particular pleasure to have such a capable and qualified group as is represented on the panel membership. You will observe from your program that the panel members have been selected to be representative of a wide variety of air pollution program levels and activity. We have two representatives from state air pollution control programs, one from a county, one from a special district and two from cities. I believe that the experience represented here will be very valuable to all of us. In addition we will be favored by comments from Mr. R.A. McCormick, representing the air pollution meteorology program at the Sanitary Engineering Center, and Dr. E.K. Harris, Chief Statistician at the Center. These will be most helpful, as I am sure we are all in need of guidance in making practical application of meteorological data and the statistical approach to a sampling program design and data evaluation.

The primary problem of a panel presentation is that of allowing adequate time for the panel members and still leave time for a healthy discussion from the floor. This panel is no exception and I am sure that each member could constructively use the entire period for his presentation. In attempting to resolve this problem, I have asked the panel members to prepare papers for inclusion in the proceedings and then be prepared to make a short, concise presentation which will describe their program, its objectives and problems and stimulate discussion. Accordingly, I will limit my own discussions so that the program can proceed.

We have designed our presentation with the primary objective of providing information based on experience to those of you who are contemplating or just undertaking some kind of a surveillance sampling program, and, secondarily, to bring added helpful experience to those who are already under way with such a program. Among those who are in the planning or just-starting stage, I am sure there are many questions. Some of which might be --

1. What is the proper objective of a sampling program?
2. What should we really be looking for?
3. What do we do with the information after we get it?
4. How do we make the sampling representative and pertinent to the objective?
5. What are the statistical considerations in designing a sampling program and evaluating the results?
6. What meteorological data is commensurate with the objectives and what is justifiable and practical of accomplishment?
7. What is the relationship of a sampling program to statutory responsibility?
8. How do we assure that the results are technically valuable and how do we interpret them to the lay official and public?

I hope that during the presentations and discussions some of these questions will be answered or sufficiently discussed to pinpoint the problems and grey areas needing further detailed consideration in your own special cases. Some of the discussion may infringe on later papers but I hope, in so doing, they will serve to stimulate thought and interest.

It is now my pleasure to proceed with the introduction of the panel members for their presentations. In consideration of the time problem, it is requested that you make note of your questions as we proceed and reserve them, together with contributions and discussion from the floor, until after the final speaker.

At this time, it gives me pleasure to introduce our first panel member, who is Mr. John Brown, Public Health Engineer with the Maryland State Health Department, Division of Occupational Health.

They are in somewhat the beginning stages of a surveillance, a monitoring program, and I think that we will get something from his viewpoint.

MR. BROWN: Thank you, Mr. Stockman.

Maryland's State Air Sampling Network is patterned after the National Air Sampling Network. In considering the type of program to be followed, a point of departure existed in the two stations of the National Network then in operation. Data from a State Network seemed a natural supplement to provide detail for evaluation of Statewide conditions.

Since techniques are identical in kind, if not in quality, the National Network station provides a control. Should too much deviation from national values occur, review of operational procedures will quickly disclose any serious fault in manipulation. Needless to say, laboratory analysis of samples is much less complete than is the practice at the Taft Center.

Preliminary evaluation of air pollution conditions in Maryland found no dangerous problems. Neither did review of data provide sufficient information to establish limits of ambient pollution. Therefore, study of general conditions seemed most advantageous.

Existing facilities were optimum for gradual development of the network. Funds were available for purchase of one high volume sampler and laboratory apparatus. Local health department personnel could operate the station. Existing laboratory personnel could determine particulate loading and the organic fraction in the total sample. Accordingly, the station was opened, and operated for a period of several months to settle procedures.

Meanwhile, sites were selected and instruments were procured for two additional stations. Acquisition of a proportional counter by another unit of the department permitted measurement of airborne radioactive compounds. The capability now exists to report the three basic elements of the sample, when the counter works.

Sites were selected to give representative data in different land use areas. One is in a city moderately industrialized; one, in a farming-dairy community; the third, in a residential area adjacent to a heavy industry. The last should be heavily polluted, but isn't. One will operate in a densely populated residential zone, while the last is to sample in an area topographically unique in the State.

Expansion of the network to include other instruments is the next phase. Meteorological data will be recorded at each station. The elements to be measured will be wind direction and speed, temperature and humidity, barometric pressure, and precipitation. Wind direction and speed are being measured at one station, as well as sulfur dioxide concentrations. Dustfall is being measured at all three stations, and at two independent stations as special studies.

A modification in method is used in collecting dustfall data. A study by Mr. Howard E. Chaney of the Maryland State Department of Health indicated that the 95% confidence statistical mean of four receptacles at each station would give more consistent values than those from a single container. In consequence, each station uses four jars.

At the station equipped with wind measuring instruments, an automatic smoke sampler is operated. This instrument will also be used at all five stations when established. With it, diurnal variations in pollution will be determined.

Data obtained in the network will be used to establish trends, to evaluate sources, and to correlate instrument readings. It is realized that units used in the three methods are not commensurate. However, each provides an index for a different time period so that, used in conjunction, the nature of a condition, whether continuous or intermittent, may be established. Corrective measures may then be more intelligently applied.

The role of meteorological data needs little explanation. Wind direction and speed aid in locating sources. Temperature and relative humidity can explain unusual findings. Barometric pressure probably has little direct effect on air pollution, but may permit limited local forecasting in the future. Definitely, local meteorological history will assist in civic planning and zoning.

To one with imperial tendencies, an air sampling and monitoring network gives many worlds to conquer. Restraint, however, must be the order of the day. Each instrument requires time to service. Charts must be read, and the readings converted to intelligible units. Resultant data must be integrated into a coherent concept. Each participant in the network must be trained to perform his particular duty.

It is easily seen, then, that a network must be kept within the capabilities of the operating agency. True, the actual work of station operation and maintenance is small. What must be considered is the volume of office and laboratory work needed and transit time between stations. Over-enthusiasm can easily lead to initiation of a program disproportionate to the agency's mission. Since stringent control is not required in Maryland, area sampling and monitoring is considered adequate.

Operation of the network has been too brief to develop the scope of statistical procedure required. Simple manual methods are used, developing the mean and median at each station. Data are not yet in suitable form for evaluation. Preliminary results show, however, that the character of the neighborhood has more influence than actual pollution.

Data obtained from the network are expected to assist in determing ambient pollution in the several areas studied, in determining the levels of pollution tolerated by the population, in providing interrelation between units used in the methods of sampling, in expediting the work required in preparing expert testimony, and providing meteorological background.

Although yet in the development phase, some data have been helpful in evaluating conditions. As might be expected, more questions are raised in these early stages than are answered. It is hoped results will, when published in the future, achieve some of the desired objectives.

MR. STOCKMAN: Thank you, John.

Every time I see him, I expect to see filter tapes coming out of the ears of our next speaker. He operates probably more of these tape samplers than any of us. I think it is going to be interesting to get at a couple of points here; what is the relationship of the sampling program to statutory responsibility and, more important, what do we do with this information; how do we really make use of it?

I think our next speaker has done something that you will find very interesting. It is a pleasure to introduce Mr. Bill Munroe, principal Public Health Engineer, New Jersey Department of Public Health.

MR. MUNROE: About four years ago, in New Jersey, our Air Sanitation Program received a windfall of money, and sometimes this is the starting point of any project. And you sit down and figure out what you are going to do with the money.

It came at the end of a budget year, and it coincided with some action at that time with the New Jersey Air Pollution Control Commission. They are about to promulgate some state-wide regulations to control smoke from open burning operations, and to regulate salvage burning, and lastly, to regulate smoke from stacks.

So in trying to decide what we might do with this money, we thought it would be desirable to tie it a little bit to the initial action of the Air Pollution Control Commission.

And in visualizing the job that was to be handed to us, we realized that, first of all, as a state agency, we would probably never be able to police an entire state for one or another form of smoke control -- burning, stacks, and so on. We felt that as a state agency, we had reason to encourage local governments to do something about smoke locally.

In a state such as New Jersey, with its many and varied sources of atmospheric contamination, a state-wide air sampling and monitoring network to evaluate the nature and degree of air contamination is a technical and financial impossibility.

No single device or instrument is capable of measuring air pollution. Air pollution means different things to different people. To persons living near chemical industries it means chemical odors, fumes, dusts, etc. To others adjacent to rendering plants or animal industries, it means odors associated with these operations. Those near garbage dumps have their own interpretations as do residents adjacent to power houses.

The New Jersey State Department of Health is equipped with limited field and laboratory facilities for the study of special problems or for use in situations where the Department feels there may be some implication of health hazard involved or when instrumentation is considered desirable to provide supporting testimony in matters of violation of public health law at state or local level. This type of equipment does not, for many reasons, lend itself to state-wide monitoring of air contamination.

Even to the casual observer, it should be evident that the nature of air contamination in New Jersey varies with the degree of urbanization, industrial activity, vehicular traffic, refuse disposal and many other factors.

However, in searching for one factor common to all, there is little doubt that smoke, or very fine air-borne particles resulting primarily from combustion processes, exists in varying quantities almost everywhere.

Although no conclusive evidence is available which would indicate that smoke in the quantities existing in the outdoor atmosphere can in itself cause physiological injury, there is some evidence that it may contribute in some manner to produce such injury. Certainly smoke is recognized by all as being objectionable if only from the viewpoint of the sanitary standards by which we live today and as being costly from the viewpoint of soiling effect and maintenance of personal property.

The soiling characteristics of smoke and the techniques of measuring quantities of smoke in the outdoor atmosphere are discussed in a voluminous literature on this subject (1, 2, 3, 4).

In recognition of the need for a simple, practical and objective method for evaluating air contamination throughout the State of New Jersey, the Air Sanitation Program of the State Department of Health designed and carried out an experimental air testing project which was started in February, 1956 and continued for one calendar year.

The project, called the "State-Wide Air Pollution Survey--Smoke Index," was limited entirely to air-borne smoke and was conducted in various areas of the State in selected suburban, urban, and industrial environments. The experiment was designed to test the value of a method of air testing and to determine if the procedures employed could provide information which would be useful in a statewide Air Sanitation Program.

OBJECTIVES

The objectives of the experiment were as follows:

1. To obtain an index of atmospheric smoke concentrations upon which to evaluate the degree and geographical distribution of smoke in the outdoor atmosphere.

2. To obtain records of the variation of the concentration of smoke in several areas of the State throughout a calendar year to determine seasonal variations.

3. To develop an index of smoke levels in the atmosphere for use in a routine procedure of classifying municipalities on the basis of air sanitation and determining objectively the need for regulation of sources of smoke.

4. To obtain background data upon which to evaluate the effectiveness of air pollution control measures.

5. To obtain background data to provide a basis for the evaluation of air pollution complaints.

INSTRUMENTATION

The instrument selected for use in this study was the A.I.S.I.* Smoke Sampler developed by the Mellon Institute and described in detail by Hemeon (1, 2, 3). The instrument is available commercially and was obtained from the Research Appliance Company, Pittsburgh, Pennsylvania.

In operation, this instrument produces a visual indication of smoke density by pumping air at approximately one-quarter cubic foot per minute for a two-hour period through a one-inch diameter spot on white Whatman No. 4 filter paper tape. By means of a timing mechanism, the tape is automatically advanced to a new position at two-hour test cycles, thereby producing one spot for every two hours of operation, or 12 spots in 24 hours.

Being automatic, the instrument can be operated for approximately 20 days with one roll of filter tape. At least once each day, a date and time reference must be noted on the tape. Each instrument, prior to use in the survey, was calibrated to determine its air pumping rate.

At each site selected in this study, an instrument was installed indoors in a room on a window ledge, or table between 10 feet and 50 feet above ground level. A four-foot section of 3/8-inch Tygon tubing was extended to the outdoors with an inverted plastic funnel on the end to prevent rain from being taken into the instrument.

*American Iron and Steel Institute

The soil produced on the filter tape varies with the amount of smoke in the outdoor atmosphere. The degree of soiling is shown as shades of gray ranging from light to black. By means of an evaluator, using light transmission through the spot, the shade can be measured photo-electrically and compared with the light transmission through clean white filter paper.

The optical density is obtained and calculated for a two-hour sampling period and in this report is expressed as soiling units per 1,000 linear feet of air passed through the paper. The soiling unit referred to in this report corresponds to the Coh unit described in detail by Hemeon in references referred to above.

For purposes of this report, it can be assumed that an "O" soiling unit represents completely clean air and "10" soiling units represent the most severe soiling conditions which can be measured by the techniques employed in the study.

Data contained in this report are expressed in units of this scale and can be interpreted as a linear measurement of the air-borne smoke level.

TEST SITES

Instruments were installed in municipally owned or supervised buildings as near to the geographical center of the municipality as possible. The initial plans for this study provided for operating instruments over one calendar year at 40 sites in New Jersey.

TABLE 1. DESCRIPTION OF TEST SITES

Test Sites	Population (a)	Land Area Sq. Miles (b)	Population Density	Site Description			
				Residential	Commercial	Light Industry	Heavy Industry
Atlantic City	61,657	11.9	5,200	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	
Boonton	7,163	2.7	2,700	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	▬▬▬
Burlington	12,051	3.1	3,900	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	▬▬▬
Camden	124,555	8.7	14,300	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬
Elizabeth	112,817	11.7	9,700	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬
Jersey City	299,017	13.5	22,100	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬
Lakehurst	1,518	1.2	1,400	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	
Lakewood	10,809	25.8	400	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	
Madison	10,417	4.0	2,600	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	
Middlesex	5,943	3.6	1,700	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	▬▬▬
Morristown	17,124	2.0	8,600	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	
Newark	438,776	24.1	18,200	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬
New Brunswick	38,811	5.5	7,100	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬
Paterson	139,336	8.3	16,800	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬
Phillipsburg	18,919	3.7	5,100	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	▬▬▬
Plainfield	42,366	6.0	7,100	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	▬▬▬
Princeton	12,230	1.8	7,000	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬		
Red Bank	12,743	1.8	7,100	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬	
Sparta	3,021	38.8	100	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬		
Trenton	128,009	7.5	17,100	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬
Union	38,004	9.0	4,200	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬ ▬ ▬ ▬▬▬	▬▬▬

(a) 1950 Census.
(b) 18th Annual Report, Division of Local Government, State of New Jersey
▬ ▬ ▬ ▬ Nature of Neighborhood Occupancy within 2-block radius of Test Site
▬▬▬▬ Nature of Neighborhood Occupancy within 2-mile radius of Test Site

For reasons beyond control, it was impossible to install equipment at all proposed sites and 35 monitoring stations were started in operation on February 15, 1956.

It became necessary to discontinue operation at five locations during the test year. For technical reasons, the data obtained from nine sites were invalidated due to instrument errors which became evident only at the end of the test year, when each instrument was rechecked in the laboratory.

A general description of the 21 monitoring sites from which reliable data was obtained is given in Table I. Figure 1 shows the general geographical distribution of the sites.

DATA

From the description of the survey procedure, it should be obvious that each test site will produce approximately 4,000 numbers in one calendar year. For this reason, it is not practical to present details of all data collected in this report.

Accordingly, data from selected sites only are presented to illustrate some of the interesting and significant characteristics of the levels and variation of smoke levels in the outdoor atmosphere.

Through a process of data reduction an effort has been made to summarize the essential elements of information considered necessary to meet the objectives of the study as set forth above.

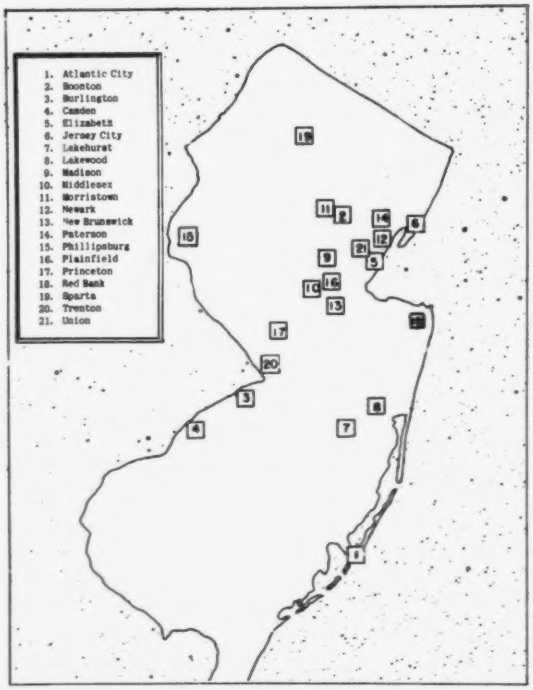
1. Atlantic City
2. Boonton
3. Burlington
4. Camden
5. Elizabeth
6. Jersey City
7. Lakehurst
8. Lakewood
9. Madison
10. Middlesex
11. Morristown
12. Newark
13. New Brunswick
14. Paterson
15. Phillipsburg
16. Plainfield
17. Princeton
18. Red Bank
19. Sparta
20. Trenton
21. Union
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Figure 1. Geographical Distribution of Test Sites

It should again be emphasized that this experiment was a test of methods and techniques. The data as presented herein are intended, therefore, to provide an indication of the capabilities and limitations of these techniques and methods. A variety of technical problems was encountered during the course of the work which might have reflected, to some extent, upon the accuracy of some of the data.

However, every effort was made to employ sound scientific disciplines and to apply generally accepted statistical procedures. It is believed that these data are within acceptable experimental error and sufficiently accurate for the purposes of arriving at reliable conclusions.

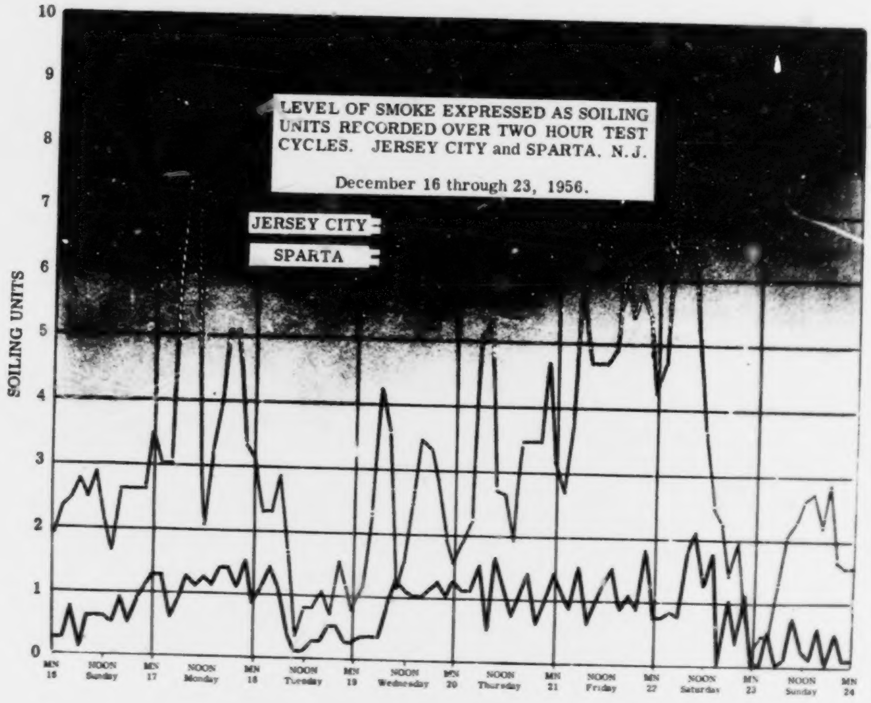
While it would be possible to present all of the individual two-hour soiling unit values for all 21 sites included in this experiment, it has been considered desirable to condense data to the minimum necessary for clarity and conclusion.

Figure 2 is a graphic illustration of the manner in which the smoke level varies at two-hour intervals. Two sites, Jersey City and Sparta, are plotted for a winter period, December 16th through 23rd,

1956. It is interesting to note that although Jersey City has a considerably higher level, the general pattern indicates that the two sites have a distinct relationship with respect to daily and hourly levels of smoke.

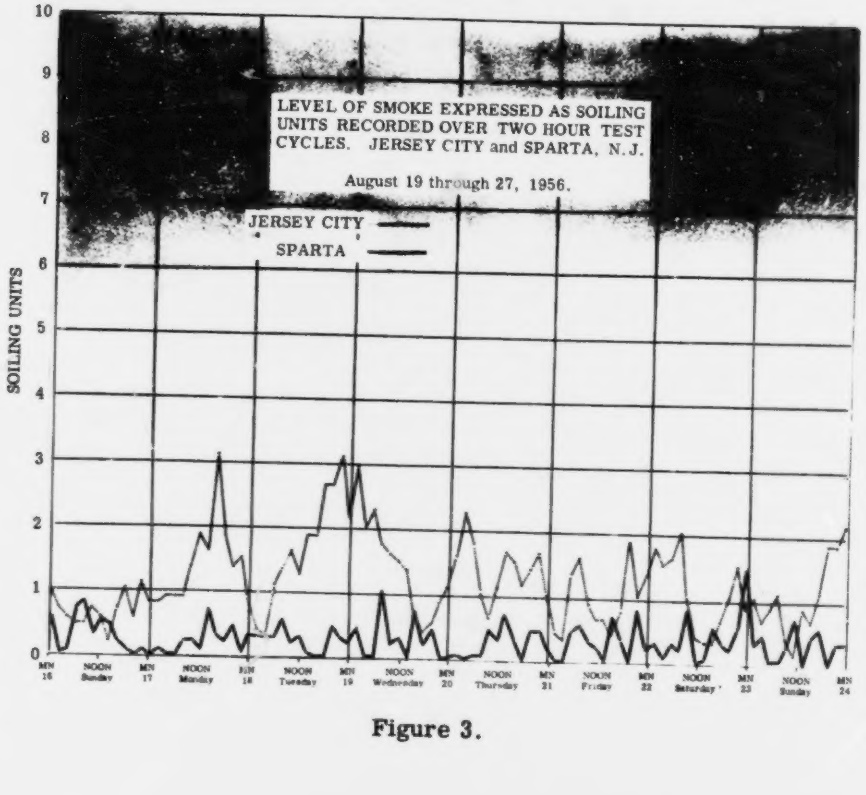
An examination of data from all sites reveals this relationship to be quite consistent throughout all sites. It appears to be a reasonable assumption that on a day or at a time when relatively higher levels of smoke are recorded at one site in the State, the levels are proportionately higher at all other locations. This is attributed, among other factors, to meteorological conditions which apparently have influence over wide areas in the State.

These meteorological factors have previously been reported by observers in other parts of the United States. Figure 3 shows data obtained from the Sparta and Jersey City sites during a summer period, August 19 through 27, 1956. Smoke levels for this period are considerably lower at both sites, but a distinct relationship between the two is shown.


LEVEL OF SMOKE EXPRESSED AS SOILING UNITS RECORDED OVER TWO HOUR TEST CYCLES. JERSEY CITY and SPARTA, N.J.

December 16 through 23, 1956.

Figure 2.


LEVEL OF SMOKE EXPRESSED AS SOILING UNITS RECORDED OVER TWO HOUR TEST CYCLES. JERSEY CITY and SPARTA, N.J.

August 19 through 27, 1956.

Figure 3.

To illustrate the general levels and seasonal variations of smoke, the individual two-hour values were averaged for each month of the year for each site. Figure 4 shows these monthly average levels for Jersey City and Sparta and the manner in which they vary with the seasons.

All sites follow the same seasonal pattern with the warm summer months having the lowest levels, and the cold winter months the highest. Although meteorology plays some part in this pattern, increased fuel burning activity is undoubtedly a prime factor.

The time of day likewise shows a marked influence upon smoke level. Figure 5 illustrates the manner in which smoke varies with the time of day at one test site during selected months of the four seasons of the year. Here again a definite pattern exists, the early morning hours being highest and the midday the lowest.

This pattern is also quite uniform throughout the 21 sites and it appears reasonable to assume that this characteristic is prevalent throughout the State. The phenom-

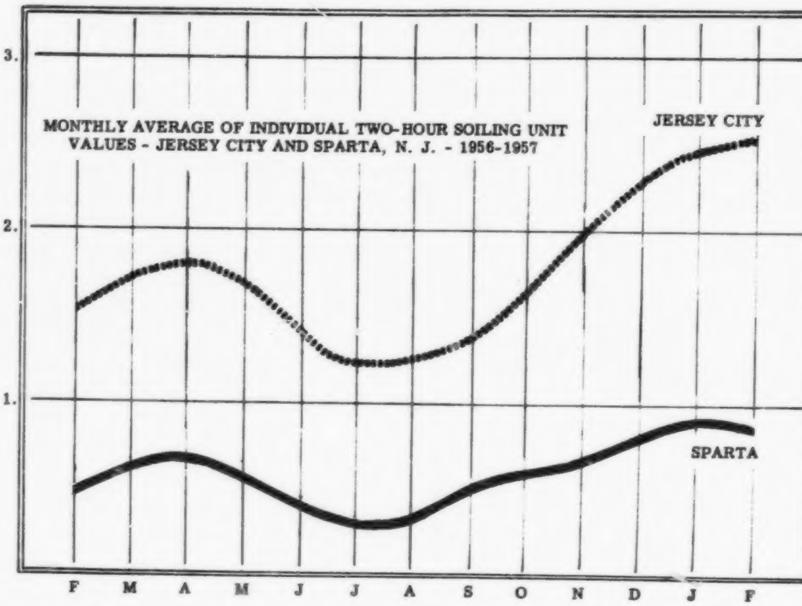


Figure 4.

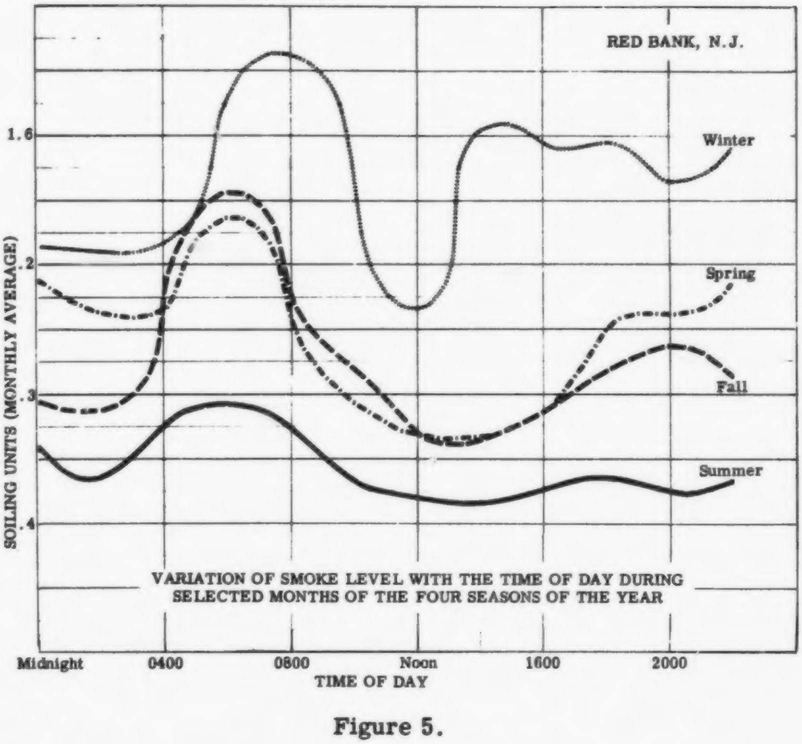


Figure 5.

enon has been reported elsewhere in the United States and is undoubtedly due almost entirely to meteorological factors.

In an effort to reduce the approximately 84,000 individual two-hour soiling unit values obtained from the 21 sites to readily understandable data, every two-hour measurement obtained from each site for the test year was grouped in a frequency distribution of five ranges. These ranges were then given adjectival ratings, based upon opinion of informed observers and a knowledge of smoke level significance in the state.

The soiling unit ranges, with assigned adjectival ratings, are as follows:

Soiling Unit Range (Smoke Level)	Adjectival Smoke Rating
0 to 0.9	Light
1 to 1.9	Moderate
2 to 2.9	Heavy
3 to 3.9	Very Heavy
4 Plus	Extremely Heavy

The total number of two-hour smoke levels in each of these five ranges was summarized for the one-year period at each test site and related to the total number of samples taken at the test site to arrive at a percentage frequency distribution. For purposes of illustration, the soiling unit ranges corresponding to the adjectival ratings have been superimposed on the graph in Figure 6.

Table 2 shows the frequency distribution. These frequency distribution values can be interpreted to indicate the percentage of time that the smoke level ranges correspond to each of the adjectival smoke ratings.

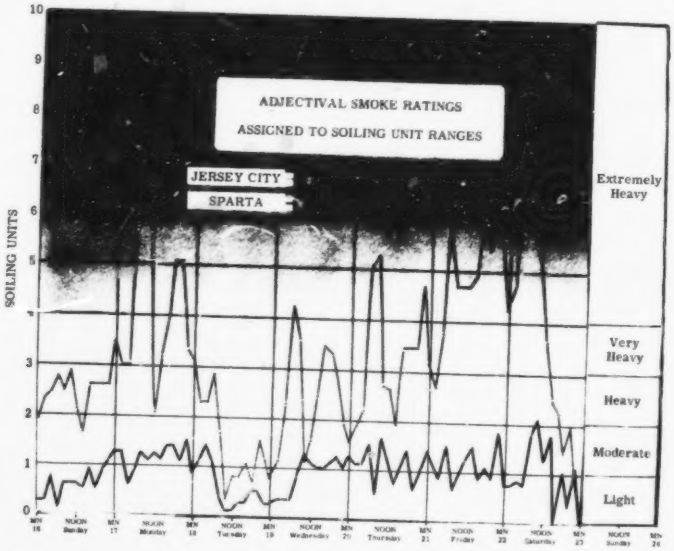


Figure 6.

Analysis of these data reveals a wide difference between test sites. Of particular significance is the percentage of time certain sites experienced HEAVY, VERY HEAVY, and EXTREMELY HEAVY smoke ratings. It is also interesting to note that in the same municipalities which have a relatively high percentage of HEAVY, VERY HEAVY and EXTREMELY HEAVY ratings, there is also a substantial period of time when LIGHT and MODERATE ratings occur. Likewise, sites which show a high frequency of LIGHT and MODERATE ratings also experience occasionally HEAVY, VERY HEAVY, and some EXTREMELY HEAVY ratings.

TABLE 2. PERCENTAGE OF TOTAL SOILING UNIT VALUES IN EACH ADJECTIVAL SMOKE LEVEL RANGE

TEST SITE	Adjectival Rating				
	Light	Moderate	Heavy	Very Heavy	Extremely Heavy
1. Lakehurst	93.0	6.7	.3		
2. Sparta	92.8	6.9	.3		
3. Lakewood	78.6	19.7	1.5	.2	
4. Princeton	77.4	19.4	2.7	.5	
5. Morristown	76.3	19.5	3.4	.6	0.2
6. Madison	73.2	23.1	3.4	.3	
7. Atlantic City	67.9	27.6	4.1	.4	
8. Burlington	67.5	26.1	5.7	.7	
9. Red Bank	67.0	26.9	5.3	.8	
10. New Brunswick	63.1	26.8	8.5	1.5	0.1
11. Middlesex	61.8	28.2	8.4	1.5	0.1
12. Boonton	59.5	33.3	6.2	1.0	
13. Union	56.9	28.6	10.7	3.1	0.7
14. Phillipsburg	51.4	35.5	11.3	1.7	0.1
15. Paterson	51.3	31.2	12.9	4.0	0.6
16. Trenton	50.0	37.1	10.8	2.0	0.1
17. Plainfield	49.6	33.9	12.5	3.5	0.5
18. Elizabeth	47.9	35.1	12.3	3.6	1.1
19. Jersey City	34.2	41.9	17.3	5.4	1.2
20. Newark	31.6	41.0	19.0	6.2	2.2
21. Camden	25.6	40.8	23.3	8.0	2.3

If it is reasonable to assume that smoke levels of LIGHT and MODERATE represent acceptable air cleanliness, it is interesting to note that a notoriously smoky city such as Jersey City is just as "clean" as the "cleanest" site, Lakehurst, for 76% of the total year.

It appeared desirable and practical to reduce these data to a single significant unit of expression which could be applied to a plan for rating municipalities on the basis of air sanitation (smoke).

It was felt that such a procedure, in order to reflect truly the problem of smoke, would necessarily have to place emphasis on the higher smoke level ratings. Accordingly, a system of weighting the percentages of time in the five adjectival smoke ratings was applied. It was decided to weight the percentages on the theory that the true significance of air-borne smoke levels increases in proportion to a geometric progression with a ratio 2 from LIGHT to EXTREMELY HEAVY ratings.

Therefore, the sum of the weighted percentages represents a total weighted numerical rating which, for the purposes of this experiment, is termed **SMOKE INDEX.**

EXAMPLE

(% Lt x 1) + (% Mod x 2) + (% Hvy x 4) + (% V Hvy x 8) + (% Ex Hvy x 16) = Smoke Index.

Various systems of weighting were tried before the geometric progression method was adopted. It was felt that this system best illustrated the magnitude of the smoke problem based upon an estimate formed from years of experience in air pollution investigation in New Jersey, and by estimates based upon evaluation by experienced observers.

It was felt that the numerical Smoke Index was sufficiently broad to allow for subdivision into five ranges which could be applied as an alphabetical classification to reflect the nature of the air sanitation (smoke) in local areas. Accordingly, the following sub-division of Smoke Index was made to provide five alphabetical classifications of municipalities.

Smoke Index Range	Alphabetical Classification
100 to 124	A
125 to 149	B
150 to 174	C
175 to 199	D
200 Plus	E

Table 3 shows the weighted percentages, the Smoke Index and the alphabetical classification for the 21 sites used in this experiment.

The classifications, as in the instances of the adjectival ratings, might appear to be somewhat arbitrary; however, again the decision was made by attempting to relate the Smoke Index ranges to the subjective estimates of experienced observers.

TABLE 3. SUMMARY OF WEIGHTED ADJECTIVAL RATING PERCENTAGES, SMOKE INDEX AND CLASSIFICATION OF MUNICIPALITY

Adjectival Rating	Light	Moderate	Heavy	Very Heavy	Extremely Heavy	Smoke Index	Classification
Weighting Factor	1	2	4	8	16		
TEST SITE							
1. Lakehurst	93.0	13.4	1.2			107.6	A
2. Sparta	92.8	13.8	1.2			107.8	A
3. Lakewood	78.6	39.4	6.0	1.6		125.6	B
4. Princeton	77.4	38.8	10.8	4.0		131.0	B
5. Madison	73.2	46.2	13.6	2.4		135.4	B
6. Morristown	76.3	39.0	13.6	4.8	3.2	136.9	B
7. Atlantic City	67.9	55.2	16.4	3.2		142.7	B
8. Burlington	67.5	52.2	22.8	5.6		148.1	B
9. Red Bank	67.0	53.8	21.2	6.4		148.4	B
10. Boonton	59.5	66.6	24.8	8.0		158.9	C
11. New Brunswick	63.1	53.6	34.0	12.0	1.6	164.3	C
12. Middlesex	61.8	56.4	33.6	12.0	1.6	165.4	C
13. Phillipsburg	51.4	71.0	45.2	13.6	1.6	182.8	D
14. Trenton	50.0	74.2	43.2	16.0	1.6	185.0	D
15. Union	56.9	57.2	42.8	24.8	11.2	192.9	D
16. Plainfield	49.6	67.8	50.0	28.0	8.0	203.4	E
17. Paterson	51.3	62.4	51.6	32.0	9.6	206.9	E
18. Elizabeth	47.9	70.2	49.2	28.8	17.6	213.7	E
19. Jersey City	34.2	83.8	69.2	43.2	19.2	249.6	E
20. Newark	31.6	82.0	76.0	49.6	35.2	274.4	E
21. Camden	25.6	81.6	93.2	64.0	36.8	301.2	E

In addition to serving as an indication of the atmospheric smoke problem within municipalities, it is felt that the alphabetical classification can also serve to demonstrate the degree of need for local regulation of smoke emissions. In this connection, however, it should be emphasized that, in most instances, the smoke levels in a municipality are, to a great extent, influenced by sources outside the political subdivisions. Accordingly, local efforts toward abatement must be a joint effort with adjoining municipalities.

The State Department of Health, under authority contained in the New Jersey Air Pollution Control Act, has responsibility for controlling sources of smoke emission throughout the State. However, the advantages of the combined effort on the part of state and local departments of health in matters of public health and sanitation have been clearly demonstrated in the many years of health administration in New Jersey.

The following application of the alphabetical classification could be used as a guide in establishing the need for a local air sanitation program.

A. Satisfactory.

B. A part-time program is desirable.

C. A part-time program is considered essential.

D. A part-time program is essential; however, a full-time program would be desirable.

E. A full-time program is considered essential.

CONCLUSION

This experiment has demonstrated that it would be possible to develop a routine procedure within the existing framework of the Air Sanitation Program of the New Jersey State Department of Health and local boards of health throughout the State for the purpose of conducting a continuous routine air testing project to obtain data on air sanitation (Smoke Index).

A project of this type could provide:

1. An index of air-borne smoke levels for use in objective evaluation of the degree and geographical distribution of smoke in the outdoor atmosphere of the State.

2. A continuous record of the variation of smoke level in various areas of th State. These levels might have application in establishing the existence of emergency situations brough about by prolonged adverse effects of meteorology.

While smoke level in itself may not indicate harmful air pollution, these data could be used to demonstrate that air contaminants are concentrating at relatively high levels near the earth's surface and that all other air-borne substances are probably concentrating in a similar manner.

3. A procedure for rating municipalities on the basis of air sanitation which could have application in determining objectively the need for local or State regulation of smoke sources.

4. A record of background data upon which to evaluate the effectiveness of air pollution control measures.

5. A standard for air cleanliness which could be used to evaluate complaints of excessive smoke made by official agencies or the general public.

The classification of municipalities and cities when released to the press served to stimulate interest in local smoke control. Several local governments have adopted smoke control ordinances and enforcement of existing local ordinances was increased. A total of 66 officials from local governments have since attended five three-day courses titled "Smoke Observation Training and Qualification Course," conducted by the New Jersey Department of Health.

The cost of operation in terms of man hours for this project was relatively high, and it would be undersirable to attempt to continue without instituting changes which would reduce cost factors.

A number of technical problems must be overcome before wide scale operation of a continuous air monitoring project could be carried out as a routine function of the State Department of Health, Air Sanitation Program. A discussion of these problems is beyond the scope of this report, except to say that some modification of the equipment must be made and that field and laboratory procedures would have to be modified and a greater degree of cooperation would be required from local agencies.

The Air Sanitation Program is attempting to develop improved techniques within the limitations of existing facilities with the objective of designing a more practical method for a state-wide air monitoring project which will be technically sound and practical from an economic viewpoint.

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ACKNOWLEDGEMENTS

The instruments at the test sites referred to in this article were serviced daily by personnel of local health departments or by other governmental agencies or institutions. The State Department of Health gratefully acknowledges the contribution of these agencies to this experimental study.

Now, if I might have a series of slides.

I show you these slides not that they are in any way unique with regard to the information presented, but because of, perhaps, the graphic way that they are being presented to the public.

This was not a technical type of presentation, but rather something designed for public consumption.

This is the characteristic two-hour variations that have been reported by many other people throughout the country who have used this method of sampling. This particular graph illustrates the difference between two municipalities in the state, one being Jersey City, the other Sparta (Figure 2).

Jersey City is considered to be a classic example of dirty air, and Sparta is a rural area in the northwest corner of the state, with very little, if any, industry in the immediate vicinity.

This is during the period December 16 to the 23rd, and this slide here gets darker towards the top deliberately -- it is intended to be dramatic.

You can see the difference between Sparta, being the lower solid line, and Jersey City, the upper dotted line. The same characteristics occur here that have been pointed out by other investigators. When level increases in one municipality, it appears to increase at that very hour and very day throughout the entire state, which supports the statements that have been made by meteorologists that vertical weather is probably a very widespread thing.

The next slide, please.

These lines, or this slide (Figure 3), indicates the difference between Sparta and Jersey City during the summer months, and I would guess that the difference between Jersey City on this slide and the previous slide is the contribution that heating, general heating in the area is making to air dirtiness.

This remaining amount here is probably due to more industrial activity than it is to heat.

The next slide, please (Figure 4).

For dramatic purposes, again, we compare the seasonable or monthly variations, monthly averages, in terms of co-units, which for purposes of our report, incidentally were called soiling units simply because we felt people might understand a word of that type much better than they would a Coh unit.

This merely shows again the characteristic variation of air dirtiness with the season of the year, the winter being the dirtier, and the summer the cleaner.

I cannot account for the difference between the two pieces of February at each end. This experiment was started on February 15, and there are 15 days on the left and 15 days on the right, and a sizeable difference between the two would illustrate that this might have to go on for a good many years before you can arrive at some reasonably reliable level.

The next slide, please (Figure 5).

This is the variations as they occur during different hours of the day, starting at the left with midnight, and to the right, 11:00 p.m., showing again the characteristics that have been reported by many other investigators, showing that somewhere between 7:00 and 9:00 in the morning is the period when highest soiling occurs, and it is probably the period when all other air contaminants concentrate the greatest.

So that we might say from this chart, this curve, and from the previous curve, that the dirtiest periods in New Jersey are going to be during the months of January and February at about six to nine in the morning. There is nothing startling about this; you all know this. But it was interesting to the public; it stimulated some interest in the subject.

Next slide, please (Figure 6).

As I indicated earlier, we were confronted with some 84,000 individual numbers. We felt that we had to reduce these to something that would be understandable not only to the public, but also to ourselves. So we decided to group, on a frequency basis, the total number of two-hour intervals that occurred in certain ranges.

The important part of this is this adjectival rating on the side.

On the left are what we call the soiling units and we assigned adjectival ratings to the soiling unit levels, and we said that anything that falls between zero and one is light soiling, or light air contamination in this case. One to two would be considered a moderate soil; two to three, heavy; three to four, very heavy; and anything above four, extremely heavy.

Now, you see that we have eliminated much of the refinement of having various levels shown by this technique.

Next slide, please (Table 2).

This is a percentage -- or this shows the percentage of time that -- in this case, five municipalities experienced these various soiling levels. These values can be stated as percentages. They are two-hour samples.

In the case of Sparta, 92.8 percent of the time they had light soiling, 6.9, moderate, and .3, heavy.

Go down to Jersey City, showing 34.2 light, 41.9 moderate, 17.3 heavy, 5.4 very heavy, and 1.2 extremely heavy.

I think the thing that is very interesting about these data here, is that a city such as Jersey City, so classically dirty, is just as clean as the cleanest area of the state for about 75 percent of the time, and that value I arrive at by adding the light and moderate percentages together.

Assuming that if the entire state has nothing but light or moderate soiling, we would probably have no problem. It can be assumed, then, that a problem occurs because of the period of time when heavy, very heavy and extremely soiling conditions occur.

This led us to believe that if we were to try to reduce this to a single number or a single index, there should be considerable penalty for the period of time in the heavy, very heavy, and extremely heavy periods.

Next slide, please (Table 3).

What we did here was to attempt to arrive at a single value for each site, which we would call a smoke index. That number we felt could be interpreted to indicate how dirty that municipality is, whether or not there is a need for local action, or control locally, -- some type of control locally.

We decided to weight the values, the percentage values that you saw on the earlier slide. In other words, the weighting system that we proposed here, that we did use, was geometric progression to the ratio two, that is, the percentage of time in light is multiplied by one; the percentage of time in two is weighted by a value of two; and in the heavy, a value of four; and very heavy, a value of eight, and extremely heavy, a value of 16.

Now, these weights would be applied to the percentages shown in the previous chart.

Now, we come up with a series of numbers which, when added across the slide there, total to what we are calling a smoke index. That single number appears to tell us what we already know.

This being an experiment, we started with a certain hypothesis. We had a fair understanding of what to expect in these municipalities, and we were really trying to make the instrumentation tell us what we thought we already knew.

The index does seem to do that. Camden was rated the worst municipality in the state, so far as soiling is concerned, and I noted in the report that was discussed earlier, the high volume sampler summary in the Air Pollution Control Journal, that Camden is just about the worst in the United States by that study. So there is some agreement there.

So we felt that we could go just a little bit further with this index and develop an even more popular way of expressing the soiling characteristic of these municipalities, and we arrive at ranges of soiling index which could be represented by an alphabetical classification.

I can't recall the range here. It isn't too important, except to say that we have selected ranges of this smoke index which represent classifications, and we are now saying that the city of Sparta is an A municipality from the soiling index viewpoint.

Atlantic City is a B, and this caused trouble no end in Atlantic City, whose commodity is presumably clean air.

The City of New Brunswick has been rated C, Jersey City and Camden, E.

The complete report -- what I am discussing here -- lists the rating on some 21 other municipalities.

Needless to say, this system of alphabetical classification did stimulate considerable local interest, which was a large part of the objective of this experiment.

A number of municipalities who had smoke control ordinances on their books, but never enforced them, became interested; local Chambers of Commerce became interested, even though we made it clear that this was an experiment, not a continuing survey.

The State Health Department offered a course in what we called smoke observation and qualification. It was a three-day course offered by the State Department of Health, which we have conducted to date five times.

Some 66 representatives from local governments have completed the course, which means that we now have 66 additional people in the state controlling smoke.

There is very definitely an increased interest in local pride, so to speak.

We feel that it is possible to continue this type of survey. However, we cannot possibly justify the time and effort on the part of the people that went into this experiment. We are now in process of developing almost completely automatic techniques for reading tapes and dropping them into one of the five slots there that we use for adjectival rating.

MODERATOR STOCKMAN: Thank you very much, Bill. I am sure there are going to be a number among the audience who will want to question you further on this during the discussion.

I think one moral of your presentation is that you don't get up early in the morning and breathe deep, that the breathing hour is after lunch. Your mention of a windfall of money makes me think of Al Rihm, and I hope that during the discussion period he will tell us how it feels to have a windfall, and then learn how to operate a network after the money is all gone.

Our next speaker is going to take a little different tack on this, and I think you will find it interesting. It is a matter, again, of selling these things to the public. You have operated a program for a number of years; how do you sustain the interest of the public? And also, we are going to talk about monitoring and sampling, using the public as a monitor, I think it a very interesting thought.

It is a pleasure to introduce Mr. Richard Schafer, Chief Smoke Regulation Engineer, the Department of Public Safety, Columbus, Ohio.

MR. SCHAFER: Gentlemen, about 1949, the City of Columbus reactivated a program which had been in legal effect, you might say, since 1909, but no one had really done too much about it, and in order to organize the situation so that they would know from time to time what progress they were making on their smoke control program under the new ordinance which was passed in '49, they set up several types of monitoring to begin with.

The first, of course, was the dust-fall jar.

Now, the dust fall jar has the advantage of being cheap, and over a period of years, at least, perhaps some advantage in being indicative of a trend.

In 1951 to '52 there was somewhere in the neighborhood of 36 tons per square mile, which has now been reduced, at the end of '58, to a little over 24 tons per square mile. That is one type of monitoring that we are continuing to do, because it gives us an indication of the direction in which we are going.

Another type of monitoring which we are doing which is cheap, but gives us an indication of the direction in which we are going, and has been going on since 1950, and that is just to climb up on a tower 200 feet above the street, and look north, east, south and west, and find out how many miles you can see that morning at 8:00.

This has given us an indication that the visibility in Columbus has gone from somewhere over four and a half, to approximately six and a quarter miles visibility average for each of those years, between '50 and '58.

In order to make a comparison with that, the airport visibility, as reported by the Weather Bureau, was also correlated at that time, and shows a similar increase in visibility.

Another type of monitoring which we in the Division started in 1955 was a percentage reflectance off of what we call a gauze cylinder. The idea behind this -- originally it was called a lace curtain test. A piece of quarter inch hardware cloth is formed into a cylinder, surgical gauze wrapped around it; it is hung underneath our dust fall stations, and oriented to the north (with the openings to the north). Then by taking -- when you open that, you can tell north, east, south and west, and you take readings across there of % reflectance.

This has shown an increase in reflectance of somewhere around 44 in 1955, to almost 60 in 1958.

This is a very reasonably priced arrangement; the only thing you need is a reflectance meter, which is not particularly expensive when we consider some of the equipment that we have seen here at the Center this morning.

Another type of monitoring which we do, and particularly on a short-term basis, in order to locate an offender or to find from whence the dirt or dust of some type or other is coming, is the sticky paper method, which has proven, in recent instances, to be very directional in locating a stack which was smoking. Actually, it wasn't smoking so much; it was more cinders than anything else.

We also are operating, on a 24-hour basis, one of the A. I. S. I. samplers which has shown an increase in cleanliness of the air over the period of five years that it has been in operation.

The Ringleman Chart is also a method of observation, coupled with the change in our ordinance which allows us to use the smoke scope. Our inspectors are doing a type of monitoring on all the stacks in the town for smoke violations.

Now that we have this data we are intending, if we can get past some of the chemical problems, to monitor the NO_2 and the SO_2 because of the high-traffic volume in certain areas of the town, for one thing, and for four or five good sources of SO_2 in the town to establish levels and prove to the companies that they are letting out these particular chemicals.

The difficulty, of course, after you have gathered all this data is, what can you do with it? In this past year we got together all the information we could, as I have spoken to you about here, and attempted to bring it into our annual report in a pictorial way to show that a definite increase in cleanliness has been going on.

However, you have the possibility of the telephone ringing continually about certain individual companies or certain individual sources.

Some days it is quiet, and some days all the lights are on. The company, perhaps, may have spent $300,000 and you know that they have made a significant contribution to cleaner air, but the public, they just don't believe it.

The visibility thing is something that they can't see the change in, although you know that there is a weight differential in favor of cleaner air.

So with the public as a monitoring system, you can find out which of the companies, or which of the sources are the most irritating to them.

And unless you solve some of their problems for them in that way, they might find that the program that you are carrying on is not really worth what they, the taxpayer, are paying for it.

One of the large problems that we have in Columbus is back yard burning. The Service Department has a total pick-up, but the people still have to burn. There must be a certain amount of arson in all of us. I recall one woman called up and wanted to know if she could burn in the back yard. I tried to be adroit and get around the question by saying, "Well, you don't have to; the Service Department's Refuse Collection will pick it up."

She wanted to know if she could burn legally in the back yard. I tried to get around it the other way, and a couple of other ways, and I finally said, "Yes, Madam, you can." She said, "I knew that officer was wrong when he put that fire out." Some policeman had put the fire out, because of a complaint from the neighbors.

So that type of thing that Mr. Brown mentioned, the different types of neighborhood, or the different types of people that you might run into -- some areas, you can take a reasonable approach to it, and other areas, no matter what you do would never be satisfactory.

There is one thing that could be used for monitoring, and would give a large sample, I believe, and of course there is a lot of if's in it, but I just toss it out for what it is worth.

These air reduction plants use a filter on their intake to equipment which reduces the air into liquid oxygen, nitrogen, etc. They collect a tremendous amount of dirt there, which might have some value if you can find an analytical procedure to use on it.

MODERATOR STOCKMAN: Thank you very much, Dick.

I think you brought up several questions of interest that will be further discussed.

There is one city in our country that's probably well-known as the home of air pollution, and probably better known as the home of air pollution control. This area is one where they have been measuring things for many, many years, and I think it might be interesting to go back, now that we are talking about network sampling and see, over a long period of time, what some of these measurements can really tell us about what is happening in a city, or what our program is doing.

It is a pleasure to present Lee Schreibeis, Acting Chief, Bureau of Air Pollution Control, Allegheny County Health Department.

MR. SCHREIBEIS: The air pollution problem in the Pittsburgh area is more than 150 years old. One of the clearest statements of the effects of pollution in this City was written in a letter from General Presley Neville, Burgess of the Borough of Pittsburgh, to the President of Council. The letter was dated June 10, 1804 and read in part:

"The general dissatisfaction which prevails and the frequent complaints which are exhibited, in consequence of the Coal Smoke from many buildings in the Borough, particularly from smithies and Blacksmith Shops, compels me to address you on this occasion. I would be extremely sorry to be in any way the means of subjecting any of our fellow citizens to unnecessary or useless expense, but in this instance not only the comfort, health and in some measure the consequence of the place, but the peace and harmony of the inhabitants depend upon the speedy measures being adopted to remedy the nuisance."

This condition, so aptly described by General Neville, existed for almost a century and a half. The literature and other records show a constant reference to the severity of the smoke pollution problem. Individuals and civic groups began to voice a desire for corrective action in the 1880's and the first law was enacted in 1895. The public's interest in air pollution and its control continued to grow and be expressed, and new laws were enacted every five or ten years.

There were seven ordinances enacted in less than fifty years. The main efforts of personnel working in the Smoke Control Bureau were directed to plant visits of commercial, industrial, and railroad and river boat facilities. Sampling programs were not inaugurated by the control agency in Pittsburgh until 1948. Prior to that time, however, several studies had been made by the Mellon Institute of Industrial Research.

DUSTFALL SAMPLING

The earliest sampling program in our area was a dustfall survey conducted in 1912-1913[1] in which the average rate of dustfall at eleven stations was 87 tons per square mile per month. Several surveys of dustfall indicated the following average values:

Year	No. of Stations	Average Insoluble Dustfall Tons/Sq. Mi./Month
1912-1913	11	87
1923-1924	11	116
1929-1930	11	97
1938-1940	100	60

Dustfall is still recognized as one of the major problems in several areas of the county. The technique of collecting dust in wide mouthed jars was perhaps the simplest measurement technique that could have been employed and was also a good method for measuring this important nuisance. The simplicity of this procedure is its greatest advantage; it has several disadvantages with which you are aware.

However, its employment as: (1) a measure of comparison of dustfall rates in different areas, and (2) an indicator of the long-range trends of dustfall in an area have considerable merit. Industrial organizations and governmental agencies in this country and abroad continue to use this technique.

In 1947 Mr. S.B. Ely, Superintendent of the Pittsburgh Bureau, organized a small laboratory and began a network dustfall sampling program. This measurement of air pollution has been continued without interruption until the present. Since the earlier investigators had reported only insoluble dustfall, this practice was continued to allow for valid comparisons.

Soluble matter was measured later and reported on occasion. The question of whether soluble, insoluble, or total solids are reported has been confusing in the past. It is, therefore, well to know just what solids are included in reported values. The dustfall concentrations in Pittsburgh over the past ten years are reported in Table 1 below.

TABLE 1. INSOLUBLE DUSTFALL RATES IN PITTSBURGH, PA.

1948 to 1958

Year	No. of Stations	Average Monthly Rate in Tons/Sq. Mi.
1948	6	51.5
1949	8	52.6
1950	8	50.3
1951	8	45.7
1952	8	45.9
1953	11	50.7
1954	12	47.6
1955	12	48.9
1956	12	49.4
1957	12	48.2
1958	12	51.4

It appears that little progress in dustfall reduction has been accomplished, but the sampling locations that have been added to the network during this ten-year period have always represented areas of higher dustfall.

Comparison of the average monthly rate at the same six sampling locations used in 1948 and 1958 indicates 51.5 and 30.5 tons per square mile per month respectively. Thus, at the same six locations a reduction in insoluble dustfall rates of 41 percent has resulted in the ten-year interval.

FINE PARTICULATE SAMPLING

The fine particulates include the smoke particles from burning coal, oil, and gasoline, the metallic fumes and oxides of metals emitted from metallurgical operations, the fine cement dust, and many, many other particles of small sizes.

The dimensions of these several types of particulates will vary over a considerable range, but are generally below one (1) micron in size. They tend to remain suspended for longer periods than coarse dusts and are deposited on vertical as well as horizontal surfaces. Their importance lies in their capacity to dirty any surface, to reduce visibility, and possibly to affect health.

Fine particulates have been "measured" by the United States Weather Bureau personnel for many years. These measurements consist of observing landmarks at known distances during each daylight hour. When the visibility is reduced by smoke or haze so that certain landmarks are not visible, the degree of reduction can be measured in several steps, and is a measure of the fine particle concentration in the atmosphere. These records are available for a number of American cities and have shown a marked reduction in smoke pollution in the Pittsburgh district.

During the early part of 1950 and succeeding years, an automatic filter paper sampler was developed at Mellon Institute under the sponsorship of the American Iron & Steel Institute. This apparatus, known as the A.I.S.I. Automatic Smoke Sampler, has been widely employed for measuring fine particles.

The sampler's main uses are for comparing pollution levels in different locales and for establishing the trends with time in an area. A network of five sampling locations was started in Pittsburgh in December 1957. See map in Figure 1.

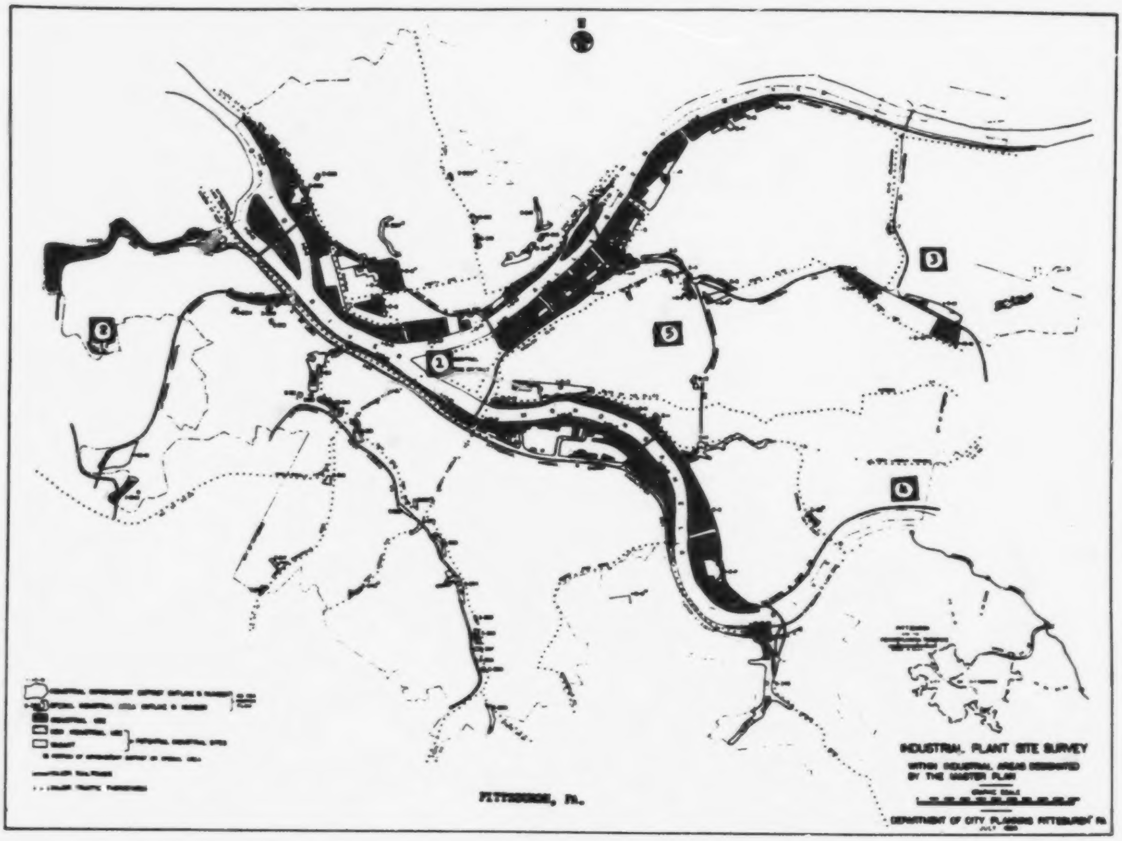
The results of the average monthly concentrations for these stations during 1958 are given in Table 2. The concentrations are expressed in units called Cohs per 1000 linear feet of a cylinder of air 1 inch in diameter[2], and abbreviated "Cohs per 1000 feet."

The range of concentrations, as measured by this technique, for two-hour sampling periods is 0 to about 10 Cohs per 1000 feet. When concentrations exceed about 10 Cohs per 1000 feet, there is loss of accuracy in the light transmission measurements, but this level of pollution is rarely measured in any urban atmosphere.

In Table 2 the range of average monthly concentrations at the five stations is between 0.7 and 3.8 Cohs per 1000 feet. The concentrations at each station are two to four times higher during the winter months. Station 3 is consistently more polluted with fine particulates but local sources are not responsible for this. The pollution is thought to be carried by the predominantly westerly winds to this site at the eastern edge of the City.

Figure 2 is a graph of the results given in Table 2 for Stations 3 and 4. Station 3 has a seasonal curve of fine particulate concentrations that is typical for Pittsburgh's climate and heating season. Station 4 is also typical except for the peak in April and May.

It is interesting to note that Station 4 is quite close to large industrial sources while Station 3 is in one of the least industrialized areas in the City.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PITTSBURGH, PA.
INDUSTRIAL PLANT SITE SURVEY
WITHIN INDUSTRIAL AREAS DESIGNATED BY THE MASTER PLAN
DEPARTMENT OF CITY PLANNING PITTSBURGH PA

Figure 1. Industrial Plant Site Survey

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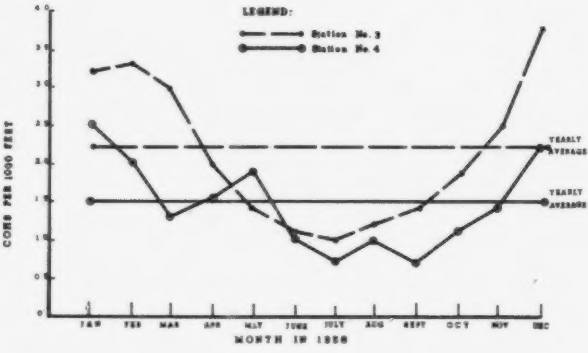


Figure 2. Graph Of Fine Particulate Concentrations As Measured By The A.I.S.I. Smoke Sampler During 1958 At Two Locations In Pittsburgh, Pa. (Data From Table 2)

Dissatisfaction with airborne particulates, predominantly settled dust, is expressed frequently by residents near Station 4. Similar types of complaints are rarely received from neighbors to Station 3. Thus, we feel that this measurement may not reflect the nuisance effects which are complained of by many residents in the Pittsburgh area.

On certain occasions fine particulate concentrations have been so high that many people notice one effect or another. The maximum daily concentrations for each month of 1958 are given in Table 3. Here again, the higher values occur in the winter months and are about two to five times the summer maximum daily values.

TABLE 2. AVERAGE MONTHLY FINE PARTICULATE CONCENTRATIONS EXPRESSED IN Cohs per 1000 FEET* AT FIVE SAMPLING LOCATIONS IN PITTSBURGH, PA.

1958

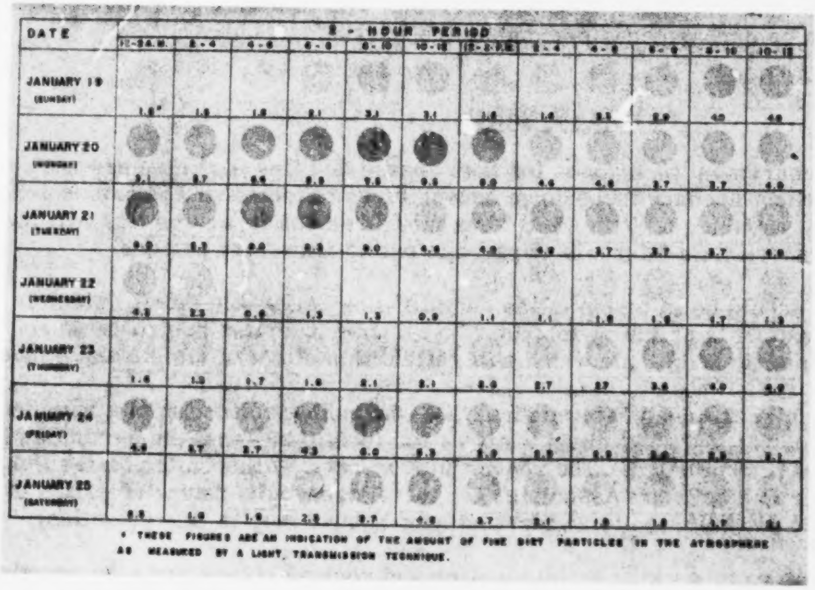
Month	Stations				
	No. 1 Down Town	No. 2 Fairywood School	No. 3 Westinghouse School	No. 4 Swisshelm Park	No. 5 University of Pittsburgh
Jan.	2.6	2.2	3.2	2.5	2.6
Feb.	2.0	1.8	3.3	2.0	2.1
Mar.	2.2	2.2	3.0	1.3	2.0
Apr.	1.8	1.7	2.0	1.6	1.6
May	1.3	1.2	1.4	1.9	1.3
June	0.9	0.8	1.1	1.0	1.0
July	0.9	0.7	1.0	0.7	0.8
Aug.	1.2	0.8	1.2	1.0	1.1
Sep.	1.3	1.0	1.4	0.7	1.3
Oct.	1.7	1.6	1.9	1.1	1.6
Nov.	1.7	1.7	2.5	1.4	1.9
Dec.	2.9	3.0	3.8	2.2	3.1
Yearly Average	1.7	1.6	2.2	1.5	1.7

*Cohs per 1000 feet are concentration units described in "Determination of Haze and Smoke Concentrations by Filter Paper Samplers," Hemeon, W.C.L., Haines, G.F., Jr., and Ide, H.M., Air Repair, August, 1953.

TABLE 3. MAXIMUM DAILY FINE PARTICULATE CONCENTRATIONS IN EACH MONTH, EXPRESSED IN Cohs per 1000 FEET AT FIVE SAMPLING LOCATIONS IN PITTSBURGH, PA.

1958

Month	Stations				
	No. 1 Down Town	No. 2 Fairywood School	No. 3 Westinghouse School	No. 4 Swisshelm Park	No. 5 University of Pittsburgh
Jan.	6.1	6.1	6.0	6.7	7.2
Feb.	4.4	4.0	4.6	4.1	4.0
Mar.	4.0	4.5	4.4	3.5	3.8
Apr.	4.0	3.8	3.2	3.1	3.0
May	2.5	2.7	3.1	2.8	2.4
June	2.1	1.4	1.8	1.8	1.9
July	2.0	1.3	1.7	1.5	1.3
Aug.	2.4	1.6	2.5	1.9	2.1
Sep.	2.8	2.1	2.8	1.4	2.7
Oct.	3.7	2.8	3.5	1.8	3.1
Nov.	3.5	4.0	4.5	2.2	3.7
Dec.	6.4	7.2	6.9	4.9	6.5



DATE

2 - HOUR PERIOD

12-2 A.M. | 2-4 | 4-6 | 6-8 | 8-10 | 10-12 | 12-2 P.M. | 2-4 | 4-6 | 6-8 | 8-10 | 10-12

JANUARY 19 (SUNDAY)

JANUARY 20 (MONDAY)

JANUARY 21 (TUESDAY)

JANUARY 22 (WEDNESDAY)

JANUARY 23 (THURSDAY)

JANUARY 24 (FRIDAY)

JANUARY 25 (SATURDAY)

* THESE FIGURES ARE AN INDICATION OF THE AMOUNT OF FINE DIRT PARTICLES IN THE ATMOSPHERE AS MEASURED BY A LIGHT, TRANSMISSION TECHNIQUE.

Figure 3. Fine Particle Concentration, City-County Bldg., Pittsburgh, Pa., For a One Week Period: Winter 1958

The maximum daily values occurred on the same day of the month in January, August, and September at all stations. This would indicate a widespread meteorological pattern, tending to prevent removal of the pollutants.

During May, July and November these maximum daily values occurred on the same day of the month at four of the five stations, again indicating the widespread effects of meteorological factors within the City.

The maximum daily concentration at the five stations during January 1958 was observed on the 20th day of the month. This particular episode was noted by many people and received comments by radio and television newscasters and the newspapers.

A chart of the filter paper sampling record at the downtown location for the week during which these high values existed is given in Figure 3. It can be seen that both Monday and Tuesday mornings were periods of high-level pollution. Fortunately, the levels decreased during the afternoons of each day and then for the remainder of the week.

The effect of wind velocity during this week is shown in Figure 4 where fine particulate concentrations (measured at the downtown station) and wind velocity are

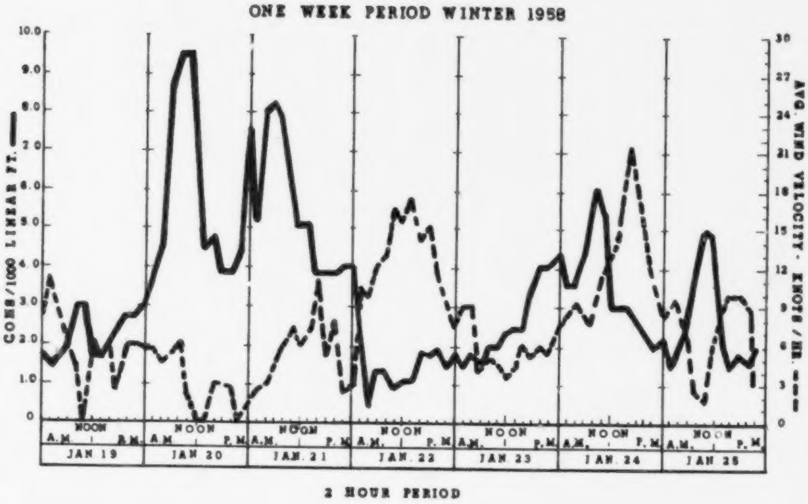


Figure 4. Relationship of Fine Particulate Concentrations and Wind Velocities, Pittsburgh, Pa.

plotted against time. Note that the pollution levels decrease with increasing wind velocities and the two lines cross on numerous occasions during the week.

FUTURE NEEDS

Available measurement techniques for both coarse and fine particles are not able to satisfy some of our present needs without large expenditures of technical and professional man-hours. Many official agencies feel the need for a measurement apparatus that will measure dustfall intensity at short-time intervals of perhaps two to four-hour periods.

The measure should be in terms of the dustfall's objectionable effect, which is not on a weight basis. Dustfall is primarily objected to because it dirties horizontal surfaces, and the measurement needed is one which will reflect this effect of visible annoyance.

We also recognize the need for a method that will enable collection of a sample of air-borne particulate matter and subsequent analysis for identifying what the particulates are and where they may have originated. The research sponsored by the United States Public Health Service with Walter C. McCrone Associates for the microscopic characterization of particulate matter found in air pollution is a giant and long-needed step in this direction.

Our Bureau has been working on this matter and several others are also devoting time to the development of a feasible solution to the identification problem.

ODORS

One of the major air pollution problems in Allegheny County is caused by numerous malodors. The human nose is the most sensitive detector of odors and has long been relied upon for their measurement. Since no workable detection device has been developed to replace the human nose, it must be employed for making measurements.

Although there may be some difficulty due to the human element, it is believed that human perception is a valid way to measure odors in air pollution problems. The real difficulty is in controlling the source.

One of the control methods for odor abatement involves dilution and in this respect odor measurement by a dilution technique is extremely useful. However, the subjective hazards of human odor measurement require a panel of several normal persons. In Allegheny County we have not employed any odor measurement instruments, except for measuring hydrogen sulfide, which will be mentioned later in connection with gas measurements.

We do not believe the lack of malodor instrumentation is hindering the progress of odor abatement. The problem is to locate the source, evaluate the cause, and select a control method such as odor masking or counteraction, dilution, combustion, or absorption. The solution lies in determining an effective odor control method, and usually has nothing to do with the measurement or network sampling of malodors.

SULFUR DIOXIDE MEASUREMENTS

Several gaseous air pollutants have long been known to damage vegetation and property. In recent years additional gases have been found to be potentially damaging.

In the Pittsburgh area there have been several occasions when the measurement of certain gases has been conducted to evaluate the magnitude of pollution in the air. Sulfur dioxide was first measured here on a broad scale in 1936-1937 by the Industrial Hygiene

Foundation, Inc. At the same time a similar study was conducted in other large cities in the country.[3]

The concentrations of sulfur dioxide found at 28 stations within a radius of five miles of the center of Pittsburgh ranged from 0 to 0.897 parts per million parts of air (ppm). During the one-year period of the survey, 3,200 samples were collected which had an average concentration of 0.078 ppm sulfur dioxide. In the winter period, the average concentration was 0.093 ppm (1727 samples) and during the summer period, 0.060 ppm (1473 samples).

Further sampling results for sulfur dioxide measurement have not been reported for Pittsburgh until in 1958 a modified Thomas Autometer was operated at three locations for a period of approximately six months (July to December). The maximum sulfur dioxide concentration measured was 0.70 ppm, but concentrations exceeding 0.50 ppm were measured on nine different occasions. The average concentrations at the three stations were 0.042, 0.048, and 0.056 ppm during a total operating time of more than 500 hours at each station.

Owing to the potentially large sources of sulfur dioxide in our County, we have thought that knowledge of trends of concentrations of this gas might be useful. The lead peroxide instruments originally designed by the British in 1932[4] have proved quite useful in this respect, and have been employed by several agencies in this country. The network was started in 1959 and the results so far obtained in Allegheny County are given in Table 4.

Stations 1 and 2 are within the City of Pittsburgh, but are not near large or significant sources of sulfur oxides. Station 3 is one of the most rural sites in Allegheny County and will reflect the lowest sulfur dioxide values measured in the County. We have placed three more stations, beginning October 1, 1959, and one of these is near large sources of sulfur dioxide.

Dr. Meetham[4] reports a range of 0.31 to 3.68 mg. SO_3 per day per 100 cm^2 PbO_2 as representing typical concentrations in Great Britain. Results in Table 4 are within this range. As more data are obtained, trends and comparisons can be made to determine what value the network measurement of sulfur dioxide by this method may provide.

TABLE 4. SULFUR DIOXIDE CONCENTRATIONS EXPRESSED AS MILLIGRAMS OF SO_3 per DAY per 100 cm^2 PbO_2* AT THREE STATIONS IN ALLEGHENY COUNTY, PA. 1959

Month	No. 1 Downtown	No. 2 Arsenal Center	No. 3 North Park
Jan.	--	2.16	--
Feb.	1.17	2.23	1.12
Mar.	1.17	1.44	0.88
Apr.	0.72	0.98	0.54
May	0.78	1.03	0.60
June	0.76	0.80	0.62
July	0.70	0.66	0.43
Aug.	0.80	0.73	0.50
Sep.	0.76	0.63	0.43

*Atmospheric Pollution, Its Origins and Prevention, Meetham, A.R., Pergamon Press, pages 167-173.

HYDROGEN SULFIDE

There are numerous sources of hydrogen sulfide in Allegheny County. Some are less significant air pollution problems and result in only occasional odor offense to limited areas. Blast furnace slag handling operations discharge this gas in varying amounts.

In one particular area we have had several house paint blackening episodes over the years and the characteristic odor frequently pervades the community. It is the most troublesome hydrogen sulfide problem in the county.

Following a paint blackening episode in this area in March 1958, we located the impregnated filter tape hydrogen sulfide sampler[5] there and have operated it continuously. We have operated additional hydrogen sulfide samplers at other locations, but the duration of measurement has been limited to from two to six months.

The results of hydrogen sulfide sampling near the blast furnace and slag handling operations are given in Table 5. This station is in a business district and adjacent to a residential area.

There is a large coke and by-product plant nearby, and a heavy concentration of steel and allied industries in contiguous areas.

The two samples which were reported as 222 ppb. or more in Table 5 exceeded the upper limit of the measurement technique and thus had to be reported in this manner.

The threshold odor of hydrogen sulfide reported by research authorities is approximately 130 ppb or more. In the 3,074 two-hour samples collected at this station in 1958, only two samples exceeded this value. Yet the characteristic odor was noted on many more occasions during this period at the station.

This would indicate that the duration of the odor perception levels of hydrogen sulfide was usually less than two hours. Results given in Table 5 also indicate that no other samples exceeded 100 ppb, except the two mentioned above, and that during any one-month period about 5 to 13 per cent of all samples measured from 10 to 100 ppb.

TABLE 5. HYDROGEN SULFIDE CONCENTRATIONS MEASURED BY IMPREGNATED FILTER PAPER[5] AND EXPRESSED IN PARTS OF H_2S per BILLION PARTS OF AIR BY VOLUME (ppb) AT STATION NO. 7.
PITTSBURGH, PA.

April through December 1958

Month	Max. 2-Hr. Concentration ppb	Per Cent of Samples With Concentrations in Stated Range ppb			Total No. 2-hr. Samples Collected
		0-10	10-100	100.1 or More	
Apr.	37	92.4	7.6	0	198
May	222 or more	93.5	6.2	0.3	372
June	97	92.3	7.7	0	367
July	97	89.3	10.7	0	310
Aug.	45	95.2	4.8	0	371
Sep.	72	88.9	11.1	0	360
Oct.	72	91.0	9.0	0	372
Nov.	222 or more	86.8	12.9	0.3	352
Dec.	33	94.9	5.1	0	372

The remaining samples were found to measure less than 10 ppb.

During this sampling period no paint damaging episodes have occurred. Neither have complaints been made by residents in the area concerning malodor or other nuisance. The results during 1959 are thus far quite similar to those of 1958. We have had two occasions where the concentration of the gas exceeded the upper limit of the sampling device, but no adverse effects have been observed.

The upper limit of measurement of the sampler can be doubled to about 500 ppb or even higher by reducing the sampling time to one hour or decreasing the sampling rate. We have not done this, owing to the infrequent occurrence of the higher concentrations. The instruments have performed extremely well, and little maintenance is required to keep them operating effectively.

OXIDANT (OZONE)

The air pollution that is provoking considerable concern in many metropolitan areas today includes numerous compounds which react or may react in the atmosphere to form irritating or toxic substances.

These atmospheric reactions appear to be enhanced by the action of sunlight and have been termed photo-chemical reactions.[6] The resulting pollutants damage vegetation, rubber products, and perhaps other types of property.

Based on the experience of Los Angeles, and the noticeable rubber deterioration in laboratory tubing, stoppers, and other rubber products in Pittsburgh, a sampling program was initiated in the summer of 1959 to determine the magnitude of the problem. The rubber supply for use in the measurement of ozone air pollution[7] was obtained and preliminary tests were run.

The visible cracks produced in the first rubber strips were greater than expected. In less than eight hours these cracks appeared. Several sampling locations were selected; the first three represented two heavy traffic areas and one less traveled area.

The results of weekly cumulative samples at these three stations are given in Table 6. Since September 4, 1959 we have added four more stations to provide a better over-all picture and an opportunity to compare areas and possibly the influence of traffic volume.

The results in Table 6 are given in millimeters of crack depth per hour of exposure. Calibration of crack depth with ozone concentration measured by absorption has not yet been completed. However, approximately 0.3 mm of crack depth per hour is equivalent to 0.1 parts per million of oxidant expressed as ozone.

Thus, the weekly average oxidant concentration has been found to range between less than 0.01 and 0.02 ppm in the two month period of measurement. These results are similar to those reported in 1955 for such cities as: Cincinnati; Charleston, West Virginia; St. Louis; Washington, D.C.; Philadelphia; and Ann Arbor, Michigan; but are much lower than the average values found in Los Angeles.[9]

The rubber cracking measurement technique is well suited to long-range studies of the atmospheric oxidant concentrations in a number of areas. The costs of equipment, materials, and manpower are certainly modest. Faced with the possibility of continued population and related growth, which may increase the oxidant air pollution problem in metropolitan areas, it is our thought that this measurement can prove quite useful.

TABLE 6. OXIDANT CONCENTRATIONS AS MEASURED BY THE RUBBER CRACKING METHOD AND EXPRESSED IN MILLIMETERS OF CRACK DEPTH PER HOUR

Pittsburgh, Pa.

Date at End of One Week Exposure (1959)	Station Location		
	No. 1 Downtown	No. 2 Arsenal Center	No. 3 East Liberty
July 17	0.014	0.028	---
July 24	0.021	0.018	0.012
July 31	0.011	0.012	0.024
Aug. 7	0.015	0.028	Lost
Aug. 14	0.033	0.033	0.044
Aug. 21	0.022	0.032	Lost
Aug. 28	0.028	0.021	0.038
Sep. 4	0.028	0.048	0.037
Sep. 11	0.037	0.019	0.038
Sep. 18	0.028	0.028	0.028
Sep. 25	0.038	0.027	0.036
Oct. 2	0.015	0.016	0.018
Oct. 9	0.025	0.029	0.034
Oct. 16	0.026	0.023	0.018

Many other gaseous air pollutants have given rise to unique problems in certain cities or have been studied to determine their potential significance as air pollutants. Among these are: carbon monoxide, aldehydes, oxides of nitrogen, hydrogen fluoride, ammonia, hydrocarbons, and other compounds.

We have measured carbon monoxide at several traffic arteries in the downtown section, and the results are quite similar to other reported studies. The other contaminants mentioned have been collected and analyzed on a few occasions, but present plans do not include a routine survey or study of these pollutants.

CONCLUSION

In the establishment of one or more sampling networks in a community, the basic considerations should be: (1) Do air pollution problems now exist or are they likely to develop within the area of interest, and (2) what use can be made of the information developed by the sampling programs?

In the Pittsburgh vicinity the biggest problem has been and continues to be, in certain areas, the deposition of solids of all sizes -- smoke, fume, dust, cinders and the like.

Consequently, the sampling efforts have been directed primarily to measuring coarse and fine particulates. Over the years we have records that show both coarse dustfall and fine (visibility reducing) solids have been greatly reduced.

The value of a network in showing this trend is limited to indicating the magnitude of the reduction. It also shows the relative improvement and permits comparisons of different areas in the network.

A more important use that can be gained from network sampling is in indicating increasing amounts of certain pollutants. For example, dustfall has been shown to be greatly reduced in several areas in the County, but is still objectionable in other areas.

The sampling network for measuring dustfall indicates this fact and has served to guide our program activities. Inspections and special studies are being conducted in two areas where dustfall is at present a severe nuisance to the community.

The contamination of air with gases, which may increase almost imperceptibly, can be effectively analyzed with a network sampling system. Such gases as sulfur dioxide, hydrogen sulfide, and ozone are frequently found in urban atmospheres and can occur in significant concentrations. Area-wide surveys of such gases will show trends and, if the concentration of a specific substance is increasing, early corrective action can be taken. It is a primary function of a network system to provide early warning of an increasing trend.

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MODERATOR STOCKMAN: Thank you very much, Lee.

I have read Lee's paper, and I know that you are going to enjoy it when you get the proceedings of the meeting; it is very complete and detailed, and there are some interesting things that he didn't have time to cover.

It is now my pleasure to introduce Mr. Charles Schumann, Air Pollution Engineer, Cincinnati Bureau of Air Pollution Control.

MR. SCHUMANN: Thank you.

I am going to confine my remarks to Cincinnati's general work and not expand too much on other things that have been covered previously, and are on the program later on.

First, I would like to say a few words about our Airborne Solids Sampling Program, which has comprised the major part of our air sampling work.

I would like to start, of course, with the old standby, the dust bowl survey.

The progress and success of any community air pollution control program is, in a large part, dependent upon the accumulation and interpretation of air monitoring data. Such data, coupled with meteorological, topographical and other factors, provide a basis for assessing the relative need for control measures within a specific city or area. Unfortunately, there exist no well defined procedures for the control agency to follow in planning and operating an adequate air quality measurements program. The varying problems that exist between communities are often unique in themselves. For this reason each community must design and establish an air monitoring program which will provide information most practical to its overall needs. And, this must be done within the boundaries of a fixed budget, usually small.

Cincinnati's air pollution measurements program is one so designed. Established in 1952, this test and research group consists of two men, a chemical engineer and a technician, functioning on an annual budget of less than $15,000 (approximately 10% of the total annual budget for the Bureau of Air Pollution Control and Heating Inspection). This two-man team is responsible not only with the actual measurements, but must record, summarize, and report all data as well.

During the past years a large part of the monitoring work has been directed toward the measurement and identification of airborne solids. A twenty station dustfall survey, a three-station soiling index station network, and the use of a sticky paper device for locating and identifying wind blown dirt particles comprise the major part of this category. A somewhat lesser portion of the work has been the sampling and study of gaseous contaminants.

THE DUSTFALL SURVEY

Cincinnati has, to the best of our knowledge, the longest continuous record of airborne solids deposits of any city in the United States. Monthly dustfall records date back to 1931, the year this survey was started. While the results obtained by such a method must be applied with a great deal of realism, valuable information concerning both localized and city-wide trends can be obtained. Figure 1, showing the yearly average dustfall for three selected stations in the industrial and commercial areas of the city, is a good example. The solid line (Brighton) represents a highly industrialized area bordering the center of railroad activity. Note the increased amounts of dirt deposits during the war years when both industry and railroads were at peak production and activities. The gradual decline, starting in 1946, reflects the gradual conversion of railroad engines from coal to diesel, and the continuing of improvements of industrial dust controls. Twenty 7-3/4 inch diameter polyethyl-

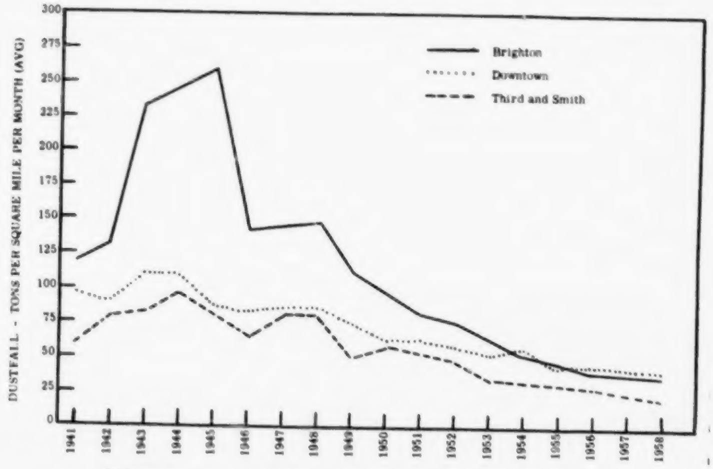

Figure 1. Yearly Average Dustfall for Three Selected Stations

ene jars, containing a mixture of glycerine and water, are used for the dustfall survey. Results are reported in tons per square mile per month, showing both combustible and incombustible portions.

THE SOILING INDEX SURVEY

Three AISI automatic filter paper samplers are maintained on a continuous basis at three selected locations within the city. One sampler is located in the downtown or basin area, another on the adjacent hilltop, and a third in a suburban section of the city. Operating on a three-hour cycle the results obtained provide a pattern of diurnal, seasonal, and yearly trends of the fine particulate matter responsible for the soiling of building exteriors, home furnishings, white shirt collars, et cetera. Figure 2 is a typical illustration obtained by the grouping of soiling index results into bi monthly averages using six-hour intervals. Seasonal trends are exhibited by the higher values recorded during the heating season; diurnal variations are also evident indicating the influence of heating demands in the build-up of fine particle concentrations. The 6 A.M. to 12 Noon periods are almost invariably the highest during the colder months when firing-up operations are the heaviest. Higher temperatures, coupled with greater air movement, are largely responsible for the lower levels during the 12 Noon to 6 P.M. periods.

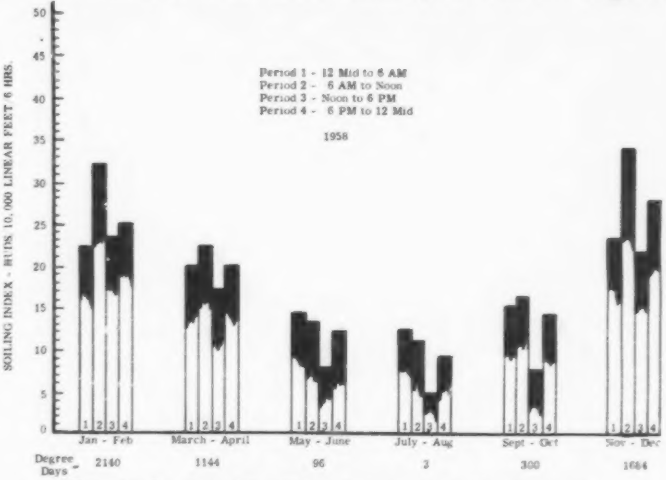

Figure 2. Bi Monthly Average Soiling Index by Periods Downtown Station

Again, the errors inherent in the use of filter paper combined with optical density evaluations prohibit the indiscriminate quantitating of such data. For this reason very little attempt has been made to correlate soiling index values with other specific air pollution factors other than humidity and visibility. It is believed, however, that this automatic filter paper instrument has a potential versatility for additional phases of air pollution monitoring. Several agencies, including this bureau, are currently engaged in research directed toward the development of an improved soiling index method using the same basic principle.

STICKY PAPER SAMPLING

This simple, relatively inexpensive method for determining direction and loadings of wind-blown dirt praticles is another Cincinnati first. Strips of sticky paper are wrapped around the sides and tops of eight-ounce glass jars and exposed for periods ranging from one day to two weeks, depending upon the dirt loading being experienced. A comparison is then made with visual standards of known particle count for the eight points of the compass and the top of the jar. This is done on a Comparator designed and built by Charles W. Gruber, Air Pollution Control and Heating Engineer, City of Cincinnati. Microscopic examinations of various segments of the sticky paper can also be made if further identification is required.

Although sticky paper sampling has been used primarily for locating sources of localized pollution, three permanent stations have been maintained for the past six years

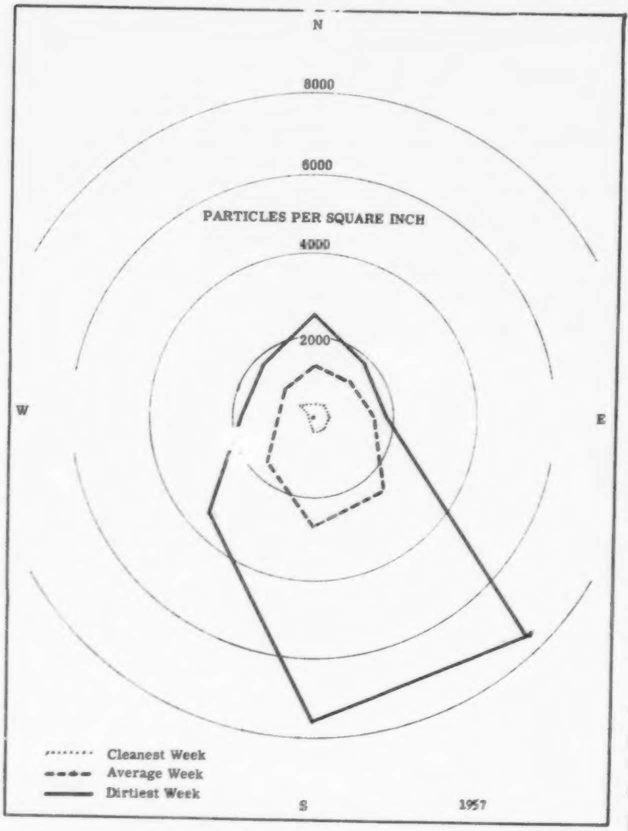

Figure 3. Residential Station, Comparative Sticky Paper Survey

alongside the soiling index sampler to provide data for possible further developments in its use. Figure 3 illustrates a typical pattern of directional dirt loading obtained at a residential station by weekly jar changes.

GAS SAMPLING PROJECTS

For previously stated economic reasons, studies of gaseous air contaminants have, by necessity, been confined to short term periodic surveys. Sampling devices used during the earlier years of the measurements program were primarily single sample inpingers. Later, a twenty-four tube Willson sequential sampler was procured and used primarily for sulfur dioxide sampling. More recently, a portable twelve impinger (100 ml. each) sequential sampler was obtained. Due to its compact size and portability this instrument has proved invaluable in the measurement of various gaseous pollutants in localized complaint situations.

Other devices used for gaseous determinations are the AISI Hydrogen Sulfide Sampler, Drager Gas Detection Kit, and the MSA Carbon Monoxide and Hydrogen Sulfide Kits. The over-all gas sampling program, although limited, has been both worthwhile and informative in all phases of investigative activities. A backlog of data has been accumulated which provides not only a means of evaluating specific localized conditions, but provides a basis for assessing future needs as well.

In any area as heavily industrialized as Cincinnati, and still growing, combined with an ever increasing number of automobiles moving on the city streets, the problems of noxious atmospheric gases are destined to become more and more acute. With this in mind, a projected plan for a continuing gas sampling program has been formulated and is now awaiting approval from the city council. This plan calls for a single station continuous monitoring of air contaminants related to automotive engine exhaust and sulfur dioxide. Specifically, the program calls for the measurement of ozone as an indicator of the degree of photochemical oxidation with levels of carbon monoxide providing an estimate of the total raw exhaust gases. Sulfur dioxide is also considered a potential problem and is therefore included. It is estimated that such a program could be established on an initial first year outlay of $18,000. For the succeeding years the expenditures would drop approximately 50% including the salary of a technician required for the maintenance of the sampling station and the take-off and recording of data. The reduction of data would be done by electronic methods on a contract basis.

SUMMARY AND CONCLUSIONS

The problems encountered in Cincinnat's air pollution monitoring program are typical of those in other communities. Economic limitations and the lack of scientific know-how affect the scope of activities. In this latter category there exists several major areas of uncertainty which must be approached with caution. For example, are the air sample results representative? If so, what are they representative of? Certainly, the collection of representative air sample data from such a large and everchanging universe as the outdoor air is not a simple, clear-cut matter. Will "spot" sampling provide the same level and trend patterns as continuous sampling at pre-selected locations? In either case the problem is how to get random samples. Although randomness, per se, cannot be defined, there may in some cases be sufficient empirical knowledge to eliminate many of the non-random factors. Nevertheless, the results obtained are, at the best, approximate.

The grouping and analyses of air sample results are necessary for correlation and regression analysis with other related factors. However, a line of limitations must be imposed upon the statistical treatment of such data. The control agency investigator must realize not only the reliability of the sample results but also the accuracy and reliability of the associated data used for correlation purposes. In conclusion, it might be stated that there is still an urgent need for standarization in collection and reporting of air monitoring data between communities. Some progress has been made, but a lot more still needs to be done. The U.S. Public Health Service National Air Sampling Network has contributed a great deal toward this accomplishment. The committee on air pollution measurements of the Air Pollution Control Association is also engaged in a much-needed project. APM-1, a "Recommended Method for Continuing Dustfall Survey" has been published. APM-2, a "Recommended Method for Fine Particle Surveys" is now in progress. Through the efforts of these and other agencies and by the exchange of ideas and information through seminars such as this, valuable benefits are to be gained by everyone concerned, either directly or indirectly, with the abatement of atmospheric contamination.

MODERATOR STOCKMAN: Thank you very much, Charlie.

To come along now to a little different aspect. In every deal there is a middleman somewhere, and I think in the air pollution field certainly the middleman is the weather, and we have the weather represented today by Bob McCormick, who is in charge of the U.S. Weather Bureau Research Station at the Robert A. Taft Sanitary Engineering Center.

To me, this is one of the most challenging aspects of air pollution, particularly from a control officer's standpoint. What must we know about the weather, and how, in a practical way can we go about learning what is happening in our community, weather-wise?

Bob.

MR. McCORMICK: Thank you, Mr. Stockman.

The successful accomplishment of meteorological tasks, either the description of the meteorological contributions to a given air pollution event, or the prediction of an episode on any scale, is circumscribed by the boundary conditions of emission and reception.

For this reason, the meteorologist must have, of necessity, a vital interest in air monitoring and sampling techniques and networks. In other words, if he is called upon to describe or predict the relation between the spatial and temporal distribution of a pollutant and meteorological parameters, he must know precisely the information which the sampling device or technique available is capable of and, indeed, does afford.

The prediction of pollution would be rather a sterile effort without the means to evaluate those predictions. Factors which can affect observed concentrations, in addition to the particular characteristics of the sampling device, are: the conditions of exposure, the location of the site relative to the surrounding objects and topography, the elevation above ground, and the degree to which the air flow about the sampler is subject to aerodynamic flow idiosyncracies.

It is appreciated that most of you are aware that meteorological factors do play a most important role in the results obtained from local and state-wide sampling networks.

If there are any doubts on this, I should like to mention two cases that we have recently been studying which underline the situation. The first involved the sampling of a specific pollutant in an urban area, two to five miles downwind from the known elevated source.

It turned out that no more than about 25% of the variation of the pollutant at the sampling site could be attributed to variation in the strength of the source. The other instance concerned sampling of a pollutant in a different urban area when the primary source was at ground level. In this situation no more than 10% of the variation in the pollutant at the sampling site was caused by the variation in the source strength. One cannot carry the implications to the extreme, of course, but these examples do show that once pollution is emitted to the atmosphere, the concentrations observed at any given location may be largely governed by the meteorology of the situation, rather than by the strength of the sources.

Meteorologists lack many of the answers to meteorological and sampling problems involved in air pollution. This is particularly true for problems of urban air pollution which involve sampling networks.

Turbulence and diffusion of air pollution involve some of the most difficult problems in classical physics. Available theory covers only the most simple cases of diffusion in a uniform atmosphere far removed from any boundaries or discontinuities of any kind.

The experimental setups have, with few exceptions, also been designed to examine the simplest cases of single source diffusion over uniform smooth terrain for relatively short distances during uncomplicated meteorological situations.

Nevertheless, these findings, supplemented by those studies which have been made in urban areas, do give us a background of knowledge and experience upon which to build; and it is in this light that the comments I should like to make are framed.

It appears that air monitoring and sampling networks are established to perform one or more of three distinct functions:

(1) To obtain so-called "base-line data" indicative of the general pollution levels of a region.

(2) To obtain quantitative information of the range in extremes of the general level of pollution or of a particular pollutant from a particular source.

(3) To obtain concentration-time or dosage data such as the duration of concentrations of a given pollutant above some predetermined level.

Common to all of these functions is the need for proper instrumental exposure, but is especially true if one is trying to get reliable data on extremes and dosages if they are to represent more than just the conditions at the point of sampling.

Now, "proper exposure" is not easy to define, but I will try to be more specific. First, relative to height of observation for base-line data I would recommend that the sampling equipment be exposed at a level free of local disturbances, such as the effective height of emission of the pollutants. One simply would have more "stuff" to work with and could operate farther away from the threshold limits of his instrument.

Furthermore, he will be sampling concentrations which can and will be experienced at ground level and which give trouble during looping conditions that bring the whole mass to the ground, or during fumigation conditions which occur with the early morning breakup of the nocturnal inversion.

Atmospheric diffusion causes a varying decrease in concentrations away from the level of emission whether it is an elevated or ground source. Particularly over cities this dispersion suffers great local variation due to the extreme roughness of the surface features and the hodgepodge of thermal sinks and sources. Therefore, to get the best measure of what is going into the air over a city and the general transport and diffusion regime, sampling at a relatively undisturbed level is the best procedure from the meteorologist's point of view.

As many samplers are located on building roof tops, care should be taken to avoid locations which, because of the geometric configuration of the surroundings, the aerodynamics results in air flow anomalies. For instance, I have seen situations on roof tops in which calm spots occurred regularly with certain wind directions even though the general wind speed was quite moderate. Work now going on with models in wind tunnels will probably solve many of these problems eventually.

In the meantime, I would suggest that simple experiments might be useful before finally settling on a particular site. Observation made with smoke candles or of the behavior of Kleenex or wool yarn streamers on a support in various wind speeds and directions could be very informative.

The location of sampling stations primarily depends upon their purpose, but wind direction or prevailing wind directions are almost always important. If one is attempting to collect the pollutants from a particular source with an air sampling station, it is a good idea to put it downwind of the source along the prevailing wind direction for the particular season in which the sampling is made. This has not always been done. Such wind data can usually be obtained from the local Weather Bureau office, which can also advise on the interpretation of the data if that is required.

In the example just given, the distance of the sampling site from the source is also meteorologically important, and you will find of practical importance, too, if you do not wish to carry on an indefinite sampling program. For instance, ground level sampling should be done near the point of maximum concentration. A little farther out than that may also be satisfactory, but the danger of going closer in could be that the reception of effluent from the source might be quite infrequent.

The formulas for computing this distance are readily found in air pollution meteorology literature. When applied to an urban environment the formulations are most likely to err in the direction of an overestimate of the distance to the point of maximum concentration; but this error is more tolerable than if it caused an underestimate.

The final matter I should like to mention is that of sampling time. The ultimate resolution or delineation of this requirement depends upon the determination and acceptance of tolerance or insult standards. Until these standards are established, the meteorological criteria which can be set up are rather academic to non-meteorologists. The most significant work which meteorologists are doing, which has a direct bearing on sampling time, is that concerned with peak-to-average concentration ratios.

It has been found from diffusion experiments over open level terrain, that surface concentrations from a single source, elevated or at the ground, decrease at a rate which is roughly proportional to the 1/5 power of the time of sampling.

In other words, if the sampling time is increased by a factor of 10, the concentration is reduced on the order of 40% of the original value. This applies to sampling times up to about 2 hours. Work is now going on in our office to uncover the rate of decrease in urban areas where the sampling site is literally submerged within the pollution from multiple and indefinite sources.

Although these studies are not complete, the evidence clearly indicates that for sources near the ground, at least, the fall-off of concentration with sampling time proceeds much slower for sampling times up to one hour. As a matter of fact, the fall-off is roughly one order of magnitude slower than the open-terrain, single-source experiments indicate. Some decrease was expected since multiple sources are involved. However, so large a decrease, if it is further substantiated, is most encouraging from a practical point of view. For one thing, it would indicate that a need for fast-response sampling equipment would be minimized, and thus the volume of data to be reduced and analyzed is lessened, aside from alleviating instrumental difficulties which would otherwise have to be overcome. It is also encouraging to report that certain regularities appear to exist between the concentration-sampling time relation and the time of day and meteorological conditions. The most optimistic view is, then, given the average 1-hour concentration, time of day, and certain simple meteorological parameters, satisfactory information on shorter-period dosages can be determined with a satisfactory degree of statistical reliability.

In conclusion, I would like to say that in this brief discussion, I have tried to point out for you the areas in which meteorologists are most concerned in network operations. In these areas meteorology can also help you. There is no general formulation into which all meteorological aspects of your problems can be thrown; meteorolcgical effects are much too subtle for that.

Those of you who have direct access to meteorological consultation from the competence on your own staff are fortunate and certainly in the best position; this is recommended for all major problem areas. Part-time assistance or consultation from private meteorological groups is and has been practiced by some agencies with various degrees of success reported.

Certainly those of you who are located where Weather Bureau facilities are available should take every opportunity to utilize those resources. You will find that they are most helpful and very often can give you the advice you seek to fit your particular problems.

MODERATOR STOCKMAN: Thank you very much, Bob.

I would like to stress the value of local contact with the Weather Bureau. I know our folks out there now have become real hobbyists, you might say, at air pollution, as we approach them with various questions, and they have been very helpful.

Until the day came when I found myself with a room full of data that I wondered how to handle, and was also faced with the problem of setting up some kind of a sampling program on a well-designed basis, I can't say that I understood the value of statisticians too well. But now I find that I can hardly operate without them. I think many of you have experienced that same thing.

I think that we can count on a few very helpful comments from Dr. E.K. Harris, the Chief Statistician at the Center here.

DR. HARRIS: I am not entirely sure just what statistical problems you people in local air sampling programs have encountered and, therefore, will make my remarks more general rather than directed towards a specific problem. I would like to say first, however, that, while the computing of means, standard deviations, and frequency distributions does not ordinarily require the services of a professional statistician, the processing of mass data to obtain these relatively simple statistics may in itself be a complex problem requiring the aid of specialists in punched card and high speed computing methods.

In listening to the presentations this morning, and in the course of my general experience with air pollution control work, I, and surely many others too, have become disturbed about the frequent lack of adequate criteria for judging how much air pollution can or should be tolerated in a given community and beyond what point it becomes a serious menace to the economic well-being or health of a community. For example, we have seen a presentation of average air pollution in each of a number of communities within a state, ranging, I believe, from a fairly rural to a highly industrialized community. Certainly, the air over an industrialized urban area will be more heavily polluted than a rural area. Is it necessarily true, however, that the cost to the community of reducing this air pollution, either by installation of equipment or by other control procedures will be less than the benefits to be derived from the lower pollution which would result? The fact is that except perhaps in Los Angeles, Pittsburgh, and some other special cases, we have no really reliable information on the economic or health loss from air pollution or, more specifically, how such loss increases as a function of increasing pollution.

To develop such information, a job which requires extensive use of sample survey techniques calls for cooperation between air sampling officials and a wide variety of specialists such as economists, physiologists, epidemiologists, veterinarians, engineers, and of course, statisticians. Many of these people are on the staffs of universities in the state. Clearly the most efficient air sampling investigations cannot be undertaken by any one group acting alone.

To me, this represents the most critical area for study today in the whole field of air pollution. However, there are other general problems which are also pressing. One of these is the construction of general mathematical models so that we may learn from one air pollution survey to another. Mr. McCormick has touched on this when he spoke of meteorological variables which should be measured before any measuring of air pollutants takes place, variables which in fact should be measured in order to define the location of air monitoring equipment. At present we do not have any general mathematical theory of community air pollution.

Attempts have been made, however, (e.g., Frenkiel of the Johns Hopkins Laboratory of Applied Physics with respect to the pattern of air pollution over Los Angeles). Moreover, there has been a considerable amount of work in recent years on situations involving the input and output of materials. Much of this work has been subsumed under the general title of operations research. Perhaps community air pollution may be put in terms of local input at various levels of the atmosphere and sweepout by winds at these heights. From such considerations, we may be able to estimate the frequency distribution of air pollutants given a reasonably adequate source inventory and information on wind speed and direction. If this is the case, then air sampling itself can become useful as a way of confirming predictions which is a much better situation than the usual case where we collect a lot of air pollution data and then wonder what to do with it. This area of work also offers considerable opportunity for cooperation between various scientific disciplines, e.g. meteorologists, air sampling experts, mathematicians, et cetera, in a coordinated fashion.

In short, I would say that in the air pollution field we are approaching the end of the beginning. It is no longer sufficient merely to embark on a program to measure air contaminants. We must begin to tie the air pollution problem in a quantitative way to considerations of economic and health loss and to mathematical models of pollution input and removal. This involves enlisting the aid of specialists in the physical, biological and medical sciences prior to undertaking a given community survey.

MODERATOR STOCKMAN: Thank you very much, Dr. Harris. I think you have given us some very fine points for consideration and I hope we will be able to discuss them.

I notice another member of our panel has arrived, and if he would care to make any comments at this time, they would be most welcome.

Dr. Mader, from Los Angeles Air Pollution Control District.

DR. MADER: I didn't prepare any particular statement to make, but I have listened to a few of the presentations and would like to make a comment on one presentation that was made, especially when it was mentioned that a station is going to be established in Cincinnati in which ozone measurements will be taken on a continuous basis.

Well, we have taken ozone measurements in Los Angeles for quite a while, and you are, of course, aware of the fact that our system is based on the measurements of five-tenths parts per million of ozone, one-tenth, and so on.

There is a certain merit to measuring ozone, because we are familiar, first of all, with the procedure of measuring ozone. One of the procedures consists in bending a strip of rubber and measuring the time it takes until cracking occurs. Another procedure may be based on the photometric determination of ozone as a specific weight. So there doesn't seem to be any doubt that it is not too difficult to measure ozone and get a good reading in a matter of minutes.

On the other hand, there are certain disadvantages to using ozone as an index of the air pollution. We have frequently observed that in days of extremely bad smog, that the ozone concentration is fairly low. Ozone by itself is not an end product of the reaction, it is an intermediary product.

It is highly reactive, and in case of bad pollutions, the ozone, of course, reacts with all kinds of other organic contaminants that are in the atmosphere, and it doesn't take very long until the ozone that is formed is quite as readily consumed as it is being formed.

Therefore, the buildup of ozone does not necessarily correspond to the amount of smog and to the amount of eye irritation that you notice in the atmosphere.

As a matter of fact, we have been very often severly criticized and asked "how come yesterday, when the pollution was so bad, that we could hardly see two blocks here, and it couldn't be any worse, but the ozone concentration was very low, and you didn't even call an alert; and on other days, let's say at 2:00 o'clock in the afternoon, most of the pollution was already gone, and you started to call an alert, based on the high ozone reading."

It seems to be the case that when the amount of sunlight available is greater, the pollution is not too bad, the amount of contaminants is not great enough to consume the ozone formed, that you get a greater buildup of ozone than in days when we have a lot of organic constituents in the atmosphere.

I would therefore say that the fact that we have been using the ozone measurement as a critical indication as far as the degree of pollution doesn't necessarily mean that it is the best thing to measure.

I can only offer you the criticism, I wouldn't know what to put instead of it. I would say that if I had a particular choice, that I would rather advance the use of the organic aerosols that we find in the atmosphere as the degree of smog, but here again you have the difficulty of measuring the organic aerosols, because you have to go through a procedure that will take you two or three hours until the actual amount of the organic portion of the aerosol is being determined. By that time, the smog is usually over, and to use this as an alert system, it would usually not work out.

So I would like to make this one comment, that it may be worthwhile to think of other contaminants that might be more suitable to give us a good indication of how great the intensity of smog is, than ozone.

MODERATOR STOCKMAN: Thank you very much, Paul. I think it is real healthy from time to time to look back and see if some of the things that we have been doing are really the criteria, and are significant.

Well, the problem has arrived that I have been worrying about now for several weeks. The time is up, and I had hoped to have a healthy period for some discussion. I think we do have a few minutes. Arnold was kind of fidgeting over there.

CHAIRMAN ARCH: May I make a suggestion? The period tomorrow afternoon from 2:45 to 4:30 has been reserved for discussion, and since there have been two more panelists than were originally scheduled, I am sure there will be a considerable amount of discussion about this panel. I don't see why it wouldn't be best to probably put off any questions on this particular panel until tomorrow afternoon.

MODERATOR STOCKMAN: Is that agreeable to the group?

MR. SMITH: If I may counter Arnold's suggestion with another one, since in part Mr. McCormick, and I believe Dr. Harris and a number of other speakers have touched upon a number of things that I would have touched upon, I will be quite happy to reduce the length of my paper, and certainly allow at least 10 or 15 minutes more for discussion now.

CHAIRMAN ARCH: May I make this suggestion: Everyone has been in here at least two hours without a break. May we now call a break, and allow Ray to give his presentation, and then the 15 minutes that he will allow on questions pertaining to his particular subject, and then any other questions can be saved until tomorrow afternoon.

MODERATOR STOCKMAN: I think that will be fine. I think his presentation follows along quite closely, too.

CHAIRMAN ARCH: The plan we are going to follow for the next hour is this: Call Ray Smith, and Mr. Hatchard, and their presentations will not take longer than 15 minutes each, so we will allow each of them to make presentations on their particular subject. At the conclusion of their half hour of presentation, we will have the general question and answer period, not only on their subjects, but also on the subjects before the panel, and of course the session will close promptly at 4:45.

Whatever questions you don't have an opportunity to ask either formally or informally can be brought up at the close of the Seminar tomorrow afternoon.

Now, the first speaker that I would like to present now is someone I know real well, and I am sure most of you gentlemen do, too.

He brings to us first-hand experiences in his work as control official in the City of Philadelphia. Ray has his problems. The City of Philadelphia has already worked out many of these problems, and inevitably they come up with some very excellent suggestions to other control officials on how to remedy their problems.

I know that Ray has given a considerable amount of thought to this particular subject, and so I will introduce him with this last remark, he is also a member of the Board of Directors of the Air Pollution Control Association.

SELECTION OF SAMPLING SITES

R. Smith

MR. SMITH: Thank you, Arnold. I wish I could agree with your comments as to what we have done. I can't honestly do so. I think that we wander around in the same never-never world that all of us involved in general air sampling are deeply immersed in, smog of our own making, perhaps.

I am reminded, certainly in this discussion of sampling sites, of one reason why we should not select a sampling site. In too many cases, it has been indicated to me that sampling sites are selected with an eye on the national network, and a comparison of cities. I am sure, after attending a meeting such as this, none of us will be prone to shift our sampling site solely for the purpose of obtaining lower dust concentrations.

I might also, by way of preface, tell you about a sign which greeted me the morning after I bawled out a very young engineer because he had forgotten to change the filter on the sampler.

It said briefly, "Ask not for whom the Staplex blows, it blows for thee. Smith, Chapter 3, Verse 4."

There, of course, are some fairly basic reasons for selecting a sampling site. We select sampling sites, in relation to four problems, all of which tie into one big problem, what do we want to sample?

If we want to sample the air people breathe, then let's say that we want to sample the air which people are really breathing; let's not confuse the issue, let's put the sampler on the person, and find out what he is breathing.

We can be interested in the effects of a specific source. Bob McCormick certainly gave us some introduction as to how you would set up a sampling system in relation to a specific source.

We could sample or select sampling sites with an eye to actually defining the true city average dust concentration, if this had any real value, which I sincerely doubt. Such a selection of sampling sites would depend, of course, on an understanding of the way the community varied in relation to zoning and population, and would certainly require samplers in light residential areas, moderate residential areas, heavy residential areas; the same thing in relation to industrial areas.

Our park lands would have to be covered, the topography in the city might very well have to be covered, and to really derive a city average, I think we would soon find that our efforts could be spent better elsewhere.

We come now to the last reason for sampling at all in the selection of sampling sites, and this is an endeavor to provide some index or trend as to what is going on in the community in relation to time and space.

I might say at this point that if new sampling stations are located in Philadelphia, they will be located with the specific purpose of correlating with meteorological data to enable us to obtain better estimates of minimum, maximum and average, natural ventilation rates in the community. And to us this is really the main worth of sampling sites. We have endeavored to locate most of our high-volume samplers, and in the following I will be speaking primarily about high-volume samplers, at relatively high points.

In retrospect, we regret that some of those placed only 30 feet or 40 feet above the ground, were not put 100 to 200 feet above the ground in an endeavor to get as far away from local disturbances as we can. We are not interested in the traffic density at a specific corner, if we are trying to evaluate the area at any distance from the sampler.

I might add that our most elevated sampler, which is some 250 feet above ground, showed a remarkable agreement with what might be called a derived average of the city's airborne dust loading, until the building that it was located on began to generate its own power.

That year, the dust concentration at that station, was the only one of our five stations which increased. The others all showed declines in yearly averages. The concentration has remained relatively high, again stressing that even at a high site, perhaps the most important consideration is the immediate influence which the site is subjected to, unless it is the immediate influence that you really want to test.

Now, going over some practical criteria in relation to sampling sites, the most important thing certainly is servicing. There is no sense in setting up a site on a rooftop when you are going to depend on a gentleman, age 60 or 65, to climb up a rickety ladder and walk a board plank over a partially broken area of the roof to reach the site and change the filter.

We had some of these experiences in our initial endeavor. Certainly, the criteria of servicing is one which must dictate, to a very great extent, where we are going to locate the site.

Another thing that we have to be acutely interested in is inconveniencing neighbors. We placed one high-volume sampler on the roof of a fire department engine house, because we were fairly certain that once established, the site would be maintained there for a long period of time. The only problem we had with this site was that firemen like to sleep. We found that as often as not on the 50 odd days of the year this sampler was run, someone had pulled the plug not too long after we had started the sampler.

The sampler is still there; it is there because it is permanently wired into the system, not merely plugged in. We have undertaken an extensive education of firemen on the importance of sampling and how to sleep with the staplex running. I am not recommending this to you as the best way of getting around nuisances.

We have similarly had difficulty with noise in residential neighborhoods where we wanted to operate samplers. Certainly, this is something you will want to consider when you establish you site.

I had mentioned, in connection with the fire department, that one of the reasons for the selection of this site was its permanency in terms of a long-range goal; - comparative data over a long period of years. We have naturally turned to municipal buildings operated by the Board of Education or others, as being sites which we will have access to for a long period of time.

In relation to such buildings, your attention should perhaps be called to the fact that if you intend to sample on Saturdays and Sundays, you of course must have means of gaining access on the weekends.

To show how objectives can change in time, and the advisability of clearly deciding what your specific purpose of sampling is before you even begin to talk about selecting sites I might mention our experience. The selection of five sites in Philadelphia originally were predicated on the idea that our prevailing winds generally were from the west. We therefore set out a group of samplers paralleling the Delaware River, which is on the eastern edge of Philadelphia. Our idea was that we would have sampling data available to us from the Pennsylvania Department of Public Health, who sample in communities to our west, which are in more or less rural areas. We similarly assumed that some data would be available to us from the New Jersey area immediately across the river. I would hate to think that the problem of Camden, a community directly across the river from Philadelphia, which was pointed up by Bill Munroe, is related to prevailing west winds. We feel now that our original assumption that our prevailing winds were from the west was erroneous. This conclusion was not reached as a defense against any implied effect of Philadelphia on results at Camden.

It is true that the wind in the Philadelphia area blows most of the time from the north to west quarter. But when the wind blows from these directions, it is usually at its most turbulent best. We now feel that these are periods of minimum pollution in the community. On the other hand, we have become increasingly convinced that when the wind blows from the southeast, the south and the southwest, our air pollution problems are probably maximal, because of its low velocity and lack of veering. If we were setting out to select our sampling sites today, we would perhaps orient them differently as a result of our new understanding.

In any event, I would strongly commend Bob McCormick's statements re the use of the meteorologist in giving you guidance and assistance in what you want to do with your samplers.

We took a jump guess. We said our winds were from the west; we now realize that the winds which are important to us are not the westerly winds at all.

We are endeavoring to rectify this error by a meteorological study which should have been made at the beginning. In any future site selection, the primary criteria will be for correlation with meteorological data to establish maximum and minimum rates of natural ventilation. The secondary reason for running these stations will be to show long-term trends.

We do not feel that our data represents a city-wide average. We feel that it shows what we would all readily admit to, that cities of over 1,000,000 population certainly have more airborne dust than cities of smaller size. And we think that this is significant enough without unwarranted city to city comparison.

CHAIRMAN ARCH: Thank you very much, Ray. In fact, you are one minute under your time limit.

The next speaker comes from one of the pioneering states in the field of air pollution control, the State of Oregon, which enacted one of the first all-inclusive state air pollution control programs.

Dick Hatchard is also a member of the Board of Directors of the Air Pollution Control Association, and he will discuss sampling stations.

EQUIPPING SAMPLING STATIONS

R. E. Hatchard

MR. HATCHARD: Thank you, Arnold. Actually, the previous speakers have paved the way very well. In fact, most of my talk will be merely a summary of the equipping of sampling stations.

Air sampling is a little like the fellow whose friend asked him what he did to keep himself in good physical condition. Well, he replied real quickly that when he gets to feeling worried about his condition, he goes to a couch and lays down and waits until that feeling passes away.

Now, in air sampling activities or extending air sampling, I think the primary thing we should think about -- and what Ray just summarized with, and what he began with -- is, what is the purpose for the sampling?

And then when you isolate the purpose or purposes, do some serious thinking about, "Can't I do this some other way?" "Hasn't somebody else done it?" "Isn't there an easier way?"

One thing that I remember from eight years of sampling and control program work in Oregon, is that some of the things we have done could have been done easier. And the part that hurts is that, like most of you, we struggle with inadequate staff, not enough equipment, and far too little money. It means we could have been doing other things, more productive for the State of Oregon, if we had started out with a more clearly defined sampling program.

So to simplify the purpose for sampling: Are you after a trend? Documenting for the future? Or are you looking towards the time when, say, your local planning and zoning agency will be asking of you, "What kind of air sanitation standards should be maintained?"

Now, being on the west coast, the future is still before us. No, honestly, what I mean is that there is a lot of growth underway. The rate of growth in Oregon is slower than our neighbor to the south, and to the north, but we are growing, and an interesting thing, that the people whose perspective we respect greatly are the planning and zoning people. They ask us, "Simply tell us what kind of air quality we should have for the kind of land use that we are trying to maintain."

What more could we ask, as air pollution engineers, or technicians? We are embarrassed; we can't tell them with any degree of accuracy or confidence on our part. This doesn't worry them one bit. They say, "Well, you tell us; if it is too high, we can adjust it." Well, they can but we are conservative and want to give them only what we think is accurate.

So one of the needs I think we all have is to develop an air quality index for our state or local regions. To do this, and equip your sampling stations to accomplish it, means looking ahead.

We haven't been troubled a great deal with gaseous contaminants from the standpoint of broad, area-wide problems. Unfortunately, this is merely a function of growth. If conditions continue as they are, we will be having area-wide problems. We are perhaps at the threshold now.

About a year ago, the Region #9 Public Health Service Engineer, Frank Bell, spent a couple of weeks with us on bringing together some gas sampling techniques with actual operations at area stations in Oregon.

While I say this was not one of our immediate needs, it is already becoming very clear that we are going to need gas sampling sooner than we thought.

So here simplified sampling techniques, very elementary equipment, midget impingers, applying modified techniques from the Taft Center, have become very helpful to us, in terms of technical assistance. This was our approach to equipping a sampling station in Oregon.

Now, I mention this, that I think all of us can simplify our sampling load by using some of the semi-automatic techniques that are available.

There have been lots of references today to sampling under known wind direction conditions. I have yet to see an effective, inexpensive wind vane electrical switch that's available commercially. About four years ago, one of our engineers developed a unit that served us effectively. Again, with a small staff, if you are interested in correlating air sanitation data with prevailing wind direction, shouldn't we be controlling the operation of our samplers to an arc of wind direction?

Well, this can be done, and it will at least cut the work in half, because you are not sampling in the opposite direction anyway. And here is a simple technique. You may not want to argue what is acceptable or desirable, air quality-wise, but instead show a ratio between the suspended particulates, when the wind is coming from the source to your sampler, compare with a sampler operating on the opposite arc. If you have got a ratio of 10, 20, or 30 to 1, you don't have to argue about whether the amount is too much. It obviously points to the excessive source, and controls, that are necessary, will follow automatically, which simplify the sampling role.

There has been at least a dozen references to use of dustfall or sootfall. We call them particle fallout jars, a very effective, simple kind of measurement, one that I think we will be doing for many years. I don't think we should depreciate its value, as long as we limit its usefulness to what it actually measures.

If you are starting a sampling program of this kind, look to the organizations that have published methods or procedures. The Air Pollution Control Association -- has published a fallout sampling method. I believe that the American Society for Testing Materials has also adopted a tentative procedure.

It will save you a lot of time and argument regarding methods, and procedures, if you use those that a respected agency also uses or are recommended by an organization reputed to fully test and develop their methods before starting to use them.

Another point, then, if you are performing the benzene extraction on suspended particulates, use the same method and same type filter that is used here at the Center by the National Network.

Now, a brief comment on another basic kind of sampler that has very wide use in some parts of the country, the so-called automatic units. I think the automatic part comes from the fact that when you invest three, four or five thousand dollars per unit, this automatically means that you need a very capable technician to keep the equipment going. They are wonderful pieces of equipment, as long as your program is geared to handle them. Our review of the use we planned suggested leasing the equipment for short periods. We have done this or borrowed one from other agencies, to get the job done where you need automatic sampling.

We haven't arrived at the point where we need continuous automatic gas sampling.

To fill in a little more on that kind of equipment for stations, when needs are developing for this kind of data, you can use semi-automatic types and do some intensive sampling. Units like impingers, that are geared to operate on a time cycle are available; you can manually start them, stop them.

A lot of data can be obtained this way, short of full-scale automatic recorder sampling. I think in the future years there will be a great increase in automatic sampling; perhaps by that time, they will perform more like their automatic name suggests.

To summarize, remember, whatever you buy or plan to buy, have the equipment geared to either present or future objectives of your program. See if you can simplify some of the operations that have been carried on; which may be your contribution to the art of air pollution control and prevention.

CHAIRMAN ARCH: Before I turn the mike back to the Moderator, who will then receive and ask for discussion on the panel discussion which preceded the presentations of Ray Smith and Dick Hatchard, I would like to take the Chairman's prerogative of making just one brief comment. I would like to admonish the group here to be extremely careful in reporting the data, for this reason: There is one thing that I know about which the Air Pollution Control Association's Board of Directors has complete agreement on, and which published finally, as resolved in agreement, a statement in the September News of the Air Pollution Control Association, and it is this:

It is the feeling of the Air Pollution Control Association, as a result of a motion made by the control officials conference at Philadelphia in 1958, that they would like to recommend to agencies which release information about sampling networks, that it is not possible, in its opinion, to compare the standards of air quality of one city with another, because of the tremendous number of variables involved.

This is about the way the statement went. I am not speaking personally; I am giving you a policy of the Board of Directors of the Air Pollution Control Association.

The reason for it was this, very simply and briefly: When a considerable amount of data has been released, and it has been released scientifically -- in fact, as I pointed out, this month's Journal gives a very fine paper by the group from the Sanitary Engineering Center here on parameters in determining justifications for comparing air quality -- the reasons here are very excellent, the reasons as stated. But when newspaper reporters are looking for a story, latching on to purely numbers, comparing one city to another, they can cause embarrassment to the control officials in these communities, and there are many control officials sitting here who know that this can happen to them.

The reason for my admonishment is this: It is difficult enough to be a control official and have to pacify the community, without having the community read that its city is the dirtiest, second dirtiest, third, or even the 20th dirtiest city in the country, or the 15th dirtiest city in the state, because then, in addition to the service to the public in your control job, you also have to contend with the politicians, who don't like to have anything bad said about the community.

But as a final shot, it is generally agreed among control officials that this is not good, but the data should be used for the purpose for which it is obtained, and it is not obtained to compare one city with another.

And on that note, I will turn the chair over to Bob Stockman, who will entertain discussions from the group.

MODERATOR STOCKMAN: Thank you very much, Arnold. What I would like to do is to call for a fast reformation of our panel. I think it would be a little more convenient if they are up here, and if we could just slide this table over a little; and Dick, if you will bring this one up, and grab your name plates, and we will get started.

While they are coming up, I might comment, I was interested in Ray's suggestion that we hang the sample on the people, if this is what we ought to sample; and this reminded me of a very recent issue of Life Magazine, with a beautiful girl and a high choker she was wearing.

I can think of nothing more delightful than using this same girl with a high-volume filter around her neck.

In regard to comments about locating stations, one little experience we had, we were locating a remote station at quite an isolated building. After three days of operation, the building burned down. We felt pretty bad about this; and I mentioned this to Ray last night, and he said, "Aren't you lucky it didn't burn down six months later, and then you couldn't go down and reproduce the data?"

I said, "On the other hand, we wanted to recover the costs, and we suggested to the owner that he pay for the equipment; and the insurance adjuster came back and took the other tack and said, 'Well, I have been thinking that probably your equipment was the thing that caused the fire.'

"So I said, 'Well, if you will forget it, we will forget it.'" So it works both ways.

Well, our panel has increased now, from roughly eight, to ten, because I think we ought to consider Ray and Dick as part of our panel. I think it fits in very nicely.

I would appreciate if, as you rise to make a question or point of discussion that you give us your name and where you are from. In most cases, I believe you will want to address your question to a particular member of the panel, and you may do so. If this is not the case, you may just raise the question and we will attempt to pick it up.

We would like not to overwork any one subject, but we would like to stay with a question or subject long enough that you feel satisfied with it before going on.

Gentlemen, the house is open.

MR. KOCH: Mr. Schafer, I understand Columbus has a performance type of industrial zoning code. Has this had any effect on your air pollution activities? Have you been called upon to help in enforcing that code, and if so, has it had any effect upon your work?

MR. SCHAFER: The code that you are speaking of, the zoning code, was put together without any consultation with the air pollution control authority. They do have within it a performance code on noise.

The question, "Is noise air pollution?" is still one to kick around. But there was no connection that I know of, at least not during the time I was there.

MR. KOCH: With particulate matter?

MR. SCHAFER: No. They are embarking, as near as I can determine, on a rehabilitation of the slum areas by the simple expedient of tearing them down and rebuilding in those areas in a different type of architecture and modern buildings.

MODERATOR STOCKMAN: Are there any more questions on this particular subject?

MR. GRUBER: This is to Mr. McCormick: Are you embarking on the project to eventually come out with a single meteorological modifier, by grouping the meteorological parameters into a number that would indicate the meteorological situation under which that sample was taken.

MR. McCORMICK: I doubt very much if one meteorological characteristic, or meteorological parameter could completely characterize the conditions which lead to accumulation of a given concentration of pollutants at a particular location in an urban area.

We are, however, working on the development of more general, air pollution potential indices, but up to now we have not arrived at one which we feel is of any great value.

MODERATOR STOCKMAN: Any further questions on this particular point?

MR. MANERI: Charles Maneri, New York State. I was particularly interested in what Bill Munroe had to say, especially in regard to the smoke index. I just wondered if he used any meteorological data to arrive at those indices.

MR. MUNROE: No consideration was given to meteorological factors. It was merely a representation of what existed during the calendar year. What caused it was not considered.

MR. FRENCH: Illinois Department of Public Health.

I would like to ask Mr. Brown, and possibly Bill Munroe if they would care to comment on the staff and the budget that it required to carry out surveys of the particular type you described.

MR. BROWN: I would say possibly one chemist, two engineers, and a technician can do the job for five stations.

MODERATOR STOCKMAN: They are doing other work, of course, besides the five stations?

MR. BROWN: Oh, yes.

It will run, let's see, about one week in a month, practically, is what it amounts to. That's about how much work they have to do on it.

MODERATOR STOCKMAN: Bill, can you add to this?

MR. MUNROE: In terms of capital outlay, a quick figure would be about $10,000 for the equipment that we used.

MR. SMITH: For how many stations?

MR. MUNROE: This was for the original 40 stations, based on a cost of $240 per sampler, plus the added cost of the analyzer.

The expendable supplies cost $300 to $400 for one-year operation.

In labor we used one man full time servicing the samplers and one woman technician doing the analysis, plus the time on the part of the supervisors to assemble and analyze the data. From here on in, cost will be primarily expendable supplies and labor. We are attempting to develop a system of automation to eliminate a good deal of the labor cost.

The cost of expendable supplies will remain the same.

In answer to your question, about a $10,000 to $11,000 capital outlay, plus labor, depending on the geography that must be covered.

MR. TABOR: I would suggest that perhaps Mr. Rihm, or Mr. Maneri might like to comment on the subject. Mr. French is concerned with operation of a state monitoring or sampling program, and I thought perhaps they could provide additional information.

MODERATOR STOCKMAN: I think Al surely can. Since he has run out of money, he is trying to figure it pretty close now.

MR. RIHM: We operated for one year, August 1, '58 until July 31, 1959, 16 stations on a daily basis. We collected somewhere -- and these are high-volume samplers -- we collected somewhere in the order of 5,000 plus samples.

Total particulates, radioactivity and benzene soluble organics were determined on every sample. On every 8th sample from each station, we did a nitrates, sulfates, pH, and in the beginning, fluorides; and on every 8th sample, we began doing the spectographic determination of metals also, but we later dropped that because of some of the limitations that Mr. Tabor touched on this morning. The benzene soluble organic materials from each station were pooled every 60 days and the pooled samples fractionated into the following organic groups: water solubles, acids, bases, aliphatic hydrocarbons, aromatic hydrocarbons, and oxy-neutral compounds.

As far as costs go, we found that it took us about close to $10,000 to equip these 16 stations with high-volume samplers, timers, sheds, or at least shelters, and so forth. At some stations, we had as many as three high-volume samplers, because we wished to keep them operating over the weekend. All of our stations were operated by volunteer personnel, and we didn't feel that we could ask them to come there every weekend; so we provided three samplers equipped with timers so that each would start and stop automatically. Actually, the stations needed attention only once every three days.

Our laboratory work was handled by contract. Three chemists, and three helpers did the actual chemical analyses. We handled this by contract for roughly $70,000 for the year. We feel that it cost us in the neighborhood of $12 per sample, exclusive of the 60 day organic fractionation which cost us about $100 per sample from each station.

MODERATOR STOCKMAN: Does that complete this question? If anyone else cares to comment, or make a note on this matter of estimate on costs?

MR. SMITH: This isn't specifically on estimate of cost as such, but Bill Munroe, I know does one thing that I personally like a lot. He certainly trys to encourage operation of these stations by local people as he can.

I am correct in saying that, am I not, Bill?

MR. MUNROE: Right. All test sites were attended by local Boards of Health.

MR. SMITH: And I wonder, really, speaking from a local agency, whether sometimes people at the state level don't tend to forget how much assistance, both in terms of money and personnel, might really be available to them at the local level if they went after it.

If you are thinking of the network totally in terms of your own cost, are you really doing as much as you can to stimulate interest in your local communities?

MR. DeMARTINI:

Mr. Munroe, you spoke this morning about getting information out to the public recently on air pollution levels and that this aroused interest and activity at the local level. What means did you use to get this information to the people? Did you report it to communities where you sampled, or did you release a state report?

MR. MUNROE: We used a press release technique in which our public relations man developed one complete story, and then where the local press was interested enough to come and seek additional information, we provided them with as much detail as they were willing to take, so that there were two types of dissemination: One, the general dissemination through our own public relations; and secondly, the follow-up type of thing, where the local reporter is told to go get more information, because the name of a municipality was in a general release.

MODERATOR STOCKMAN: Dick?

MR. HATCHARD: Another one to Bill Munroe: Did any objections develop on the part of the communities that were characterized in the lower echelon of your clean air?

MR. MUNROE: Oddly enough, no. They seemed to be quite willing to accept what we said as being completely true, and there were no arguments with our data. We found that certain Chambers of Commerce did bring the matter up within their structures; and rather than debate the factual aspect of the report, they chose to act objectively and encourage the membership to do something about it.

MODERATOR STOCKMAN: Bill, might I ask, is it possible there could be a reversal where the so-called cleaner communities say, "Well, we are cleaner than the next town over, so things don't look so bad; we will wait until we get that dirty before we start."

MR. MUNROE: If they all strived to achieve the A rating, we would have no objection to this.

MODERATOR STOCKMAN: The point is, I think, that we ought to look at a baseline for a community, instead of worrying too much about some other community or state throughout the country. We have got to decide what are the problems of the community, and where is our baseline, and are we going to hold our own, or improve.

MR. RIHM: I would like to make a comment on what Ray Smith talked about a minute ago.

I think the states can perform a real service in establishing state-wide networks insofar as local communities are concerned. Experience in our state has shown that a network like ours creates a desire on the part of local communities to initiate sampling locally.

If Arnold Arch were here, I think he would confirm that the location of a state sampling station in the Niagara Falls area provided him with support in their attempt to establish their own sampling program. It also may have provided some additional backing which resulted in the approval of their budget request for laboratory support of their proposed sampling program.

So I think just setting up these state networks, just as the Federal Government set up a national network, assists in generating interest in sampling within local communities or in getting the log rolling.

MODERATOR STOCKMAN: Mr. Stern.

MR. STERN: So many of the gentlemen at the table have indicated that they put so much faith in their records of dustfall that I am curious as to whether they would propose that the national sampling network incorporate dustfall measurements which we do not now include.

MODERATOR STOCKMAN: Does anyone on the panel care to comment on this point?

MR. SCHAFER: I would like to say something to that, Mr. Stern.

I believe that we have these dustfall jars just sort of like Topsy -- they grew up, and I see no reason why the national network should incorporate that particular thing, although we locally may be -- well, stuck with it, until we can get other methods over a sufficient period of time.

MR. SMITH: It seems that if you are going to set up network sampling, wherein you are going to try to characterize cities, even in terms of class, by limited numbers of stations, that the tendency would be to set up a network of samplers which would not be so drastically affected by the immediately adjacent disturbing influences.

Now, certainly if we know that the high-volume samplers are affected by the sources immediately surrounding them I think that we have even more reason to believe that the dustfall jar is far, far more adversely affected. I don't believe that you want to start comparing communities on the basis of one dustfall jar, which perhaps only records a dustfall level for the roof that it is on.

MODERATOR STOCKMAN: Lee?

MR. SCHREIBEIS: I don't think the Public Health Service should conduct a network dustfall measurement program either. A dustfall measurement is a measure of the nuisance value over a relatively limited area, such as the roof on which the dustfall jar is located, or perhaps a slightly larger area, depending on the location of air-borne dust sources. I understand that the Public Health Service has in mind, among other things, the measurement of potential health effects of air pollutants with their network program. One will certainly not get any measurement of potential health effects from a dustfall survey.

MODERATOR STOCKMAN: John Pate, I think might have some particular interest.

MR. PATE: I just wanted to ask Dick Hatchard if he cared to comment on this.

MR. HATCHARD: On this particle fallout?

MR. PATE: On this question of using one jar.

MR. HATCHARD: We have really not found that we can use one jar. Some Oregon communities are favorably situated for sampling in that rural country is located within three or four miles, and the sampling collects essentially fallout from natural sources. Even in cities that include an area of eight or ten square miles, we would use four or five fallout stations and one of them would be out in the rural area.

In Portland, which has some 72 square miles within its boundaries, and a population of about a half a million, including the suburbs, we used 30 fallout locations. Even then, when reporting data, we were most reluctant to speak of tons per square mile per month, particularly to a technical group since we were really measuring milligrams per month. This is the way their records are kept, and we have recently converted to milligrams per square centimeter per month.

MODERATOR STOCKMAN: Dick, while you are still on your feet, I believe one of our panel members, maybe Lee, indicated this morning a need for techniques in short-period fallout, maybe in a matter of hours, and so on.

I know you have done some work on this. Would you care to comment?

MR. HATCHARD: This arises from a considerable number of our complaint problems. Although we are a state agency trying to energize local communities, we still get involved with specific problems.

A lot of them are lumber industry conditions which really shouldn't exist, but they do, and they are short-time problems, -- hog fuel fired steam generating plants, where the mill has too much waste wood and the incinerator is loaded, too, so they burn it through the steam plant.

Well, this means a tremendous discharge which may occur only in four or five hours in a particular day.

Well, obviously sampling on the month's fallout, you are taking the peak, and just flattening it down to a low level.

So we have used 14" x 24" polyethylene trays for experimentally measuring the short time fallout peaks.

I think our conclusion from this is, we need more regulations to describe the short-term fallout, because in almost every case we go to sample, we can show some violations, based on our longer period of regulation basis.

MODERATOR STOCKMAN: Thank you. We have time for one more very potent question that requires a short answer.

MR. GRUBER: I will just add a comment. On the short-time particulate sample, I don't think you can beat the circular sticky jar to trap the particulates that can be seen, and the catch is directional to show source location.

MODERATOR STOCKMAN: Gentlemen, Arnold cautioned me he had to catch a plane, and he cautioned me to be sure and stop on time. I regret we have to stop; it has been interesting.

I thank you for your thoughts and discussions, and especially the panel members for their presentations.

The meeting adjourned.

MORNING SESSION

The Second Meeting of the Seminar on Air Monitoring and Sampling Networks was convened at 8:30 a. m. Tuesday, November 24, 1959, with Mr. Charles W. Gruber, Chairman, presiding.

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CHAIRMAN GRUBER: Good morning, ladies and gentlemen. Yesterday at the opening session discussion centered around the objectives of the National Air Sampling Network, the various aspects of sampling, the selection of the sampling site, and equipping sampling stations. This morning the program continues with four subjects: Operation of Stations, Laboratory Support and two phases of data processing.

The first speaker, Mr. Charles Maneri, is Chief of the Air Pollution Control Section of the Bureau of Environmental Sanitation of the New York State Health Department. Mr. Maneri will talk about the operation of sampling stations.

OPERATION OF STATIONS

Charles S. Maneri

MR. MANERI: Thank you, Mr. Gruber.

On August 1, 1958 a network of 15 air sampling stations went into operation covering important portions of the State. The undertaking of this network was a highly significant incident for it was the first of its kind, to our knowledge, ever to be instituted within a state for the daily sampling of air utilizing high volume air samplers. For an entire year samples were taken daily at these 15 stations and analyzed to determine what was in the air and in what quantities. This was one of the first major projects undertaken by the newly formed Air Pollution Control Board.

The project was undertaken by the Board soon after it was organized in 1957 because there was a dearth of analytical data from which could be learned the kind and quantity of contaminants which are present in the atmosphere despite the fact that air pollution control activities had been carried out for many years at a local level. The exception, other than for sootfall data in a number of the major cities, is New York City where extensive laboratory work had been carried out for a number of years.(1) There were no other laboratories engaged in this activity in the State.

Let's take a look for a moment at the way in which the Air Pollution Control Board is organized and the way in which it works.

In April 1957 the New York State Legislature passed Article 12-A of the Public Health Law, entitled the "Air Pollution Control Act." This legislation, among other things, established a nine-member board which has wide duties, powers and responsibilities in regard to air pollution matters within the State. The Board is composed of the commissioners of the Departments of Agriculture and Markets, Commerce, Conservation, Health and Labor besides one representative for each of the engineering and medical professions, industry and local government.

The Act became effective on July 1, 1957 but any enforcement powers of the Board could not be exercised until July 1, 1959. The exception to this rule was in regard to air pollution which was deleterious to public health, where the Board could prohibit the discharge of these emissions immediately, provided a public hearing was held within 15 days. The two-year period was to be used in preparing a program plan, recruiting and training staff and in studying the air pollution problem within the state.

Analytical data was available for some cities which had participated in the National Air Sampling Network. However, other than New York City and Buffalo, which were scheduled on a perennial basis, the samplers in the seven other cities operated either biennially or triennially. Furthermore, the samples collected under this program were on a biweekly random basis, so that, at most, only 26 samples could be collected from each site during any one year.

Hence, a decision was reached to undertake a statewide air sampling network modeled after the National network, but differing in several important aspects. This

(1) Greenburg, L. and Jacobs, M. B., "Sulfur Dioxide in New York City Atmosphere". Industrial and Engineering Chemistry, Vol. 48, No. 9. (1956)

network was to begin operation on April 1, 1958 but because of difficulties in arranging for the necessary laboratory support, sampling was not begun until August 1, 1958. This network continued for a full year in order to obtain at least the minimum length of record. One of the aims of this program was to obtain data in regard to the variability in contaminant levels on a daily and a monthly basis, as well as seasonally.

Because of obvious limitations a decision was reached to limit the network to the 15 stations. Each of these stations was to be sampled daily. In order to select the stations, population was used as a criterion, although it was recognized that it might be desirable to sample other areas that did not meet this standard. All cities with a population of 50,000 or greater, of which there were 13, were selected besides another that represented a population complex of one-half million or more. There was one exception, however, in that a village, located in an area of tremendous industrial potential was also included in order that data could be obtained which might show the impact of a changing economy on air pollution levels. The cities included in the network were Albany, Binghamton, Buffalo, Elmira, Glen Cove, New Rochelle, New York City, Niagara Falls, Rochester, Schenectady, Syracuse, Troy, Utica and Yonkers, and the village of Massena. Thus, all areas of the State were represented except for the extreme southwest portion, easterly Long Island and the two Forest Preserve areas.

In order to obtain operators for these sampling stations the field offices of the State Health Department were circularized to determine which local agencies were interested and willing to cooperate with this project. Local participation was encouraged as air pollution control activities, for the most part consisting of smoke abatement, had been carried out in the past by agencies within local government structure. Also, the Air Pollution Control Act charged the Board to cooperate with local agencies and foster air pollution control on the local level.

The response was gratifying as in each of the selected municipalities, satisfactory arrangements were completed to have the sampling equipment operated by local personnel. The variety of local agencies that participated is indicated by the following table:

Table 1.

Health Departments	8
Public Works Departments	5
Air Pollution Control Department	1
Other	1
	15

Concurrent with the selection of the cities to be sampled, there were many problems that had to be resolved. Since an activity of this magnitude and type had not been previously undertaken within the State, the Public Health Service was called upon for guidance and counsel on numerous occasions, and the advice that was received was of inestimable help.

One of the first decisions that had to be made was in regard to the type of equipment to be used. This was true for the sampler itself as well as for the appurtenant equipment such as sampler housing, meters, tubing and other items. After a study of the available high volume air samplers, a decision was reached to install the sampler manufactured by the General Metal Works. (2) This decision was based in part on the ease of replacing brushes and motors as well as on the favorable price comparison with other similar units. The ease of replacement was important inasmuch as the daily operation of these units would require frequent replacement of both brushes and motors. The housing for the sampler was of the same type used in the National Network and was manufactured within the Department.

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(2) General Metal Works, Cleves, Ohio - Model GNMW-2000

Since the temperature in New York State may vary as much as 120°F. between extremes, careful consideration was given to the tubing which was used to connect the sampler to the flowmeter. Rubber as well as several synthetic tubings, upon investigation, proved to be unsatisfactory for a number of reasons such as cracking, deterioration in sunlight and brittleness due to cold. Tygon tubing proved to be the most satisfactory, provided the type used was designed to remain plastic from -50°F. to 225°F. Subsequent experience with the network justified this choice as there were no difficulties reported with this tubing.

Once the sites had been selected and the equipment purchased, the installation of the equipment was undertaken. It was anticipated that training of the operators of the equipment would be necessary. Although some of the same personnel operating samplers under the National Air Sampling Network would be participating, there were a large number who had no previous experience with the equipment. Accordingly, a manual was prepared, outlining procedures that were to be followed in placing and removing filters, replacing brushes and motors, filling out the data cards, obtaining the necessary flow readings and provide general information as to the equipment and its operation. When the equipment was installed, the engineer delivering the sampler provided on-the-site training in regard to the fundamentals outlined above. The result was that after a short period, the operating personnel were familiar enough with the equipment to service it as required as well as to carry out any necessary field repairs.

As there were no facilities available within the Health Department to do the laboratory work, a decision was made to have the work done by contract with a qualified laboratory. Proposals were solicited from several interested laboratories, and bids requested. The analytical work to be performed consisted of the following:

1. Daily determinations for total particulates, the benzene soluble portion of the particulates and the gross β radioactivity.

2. Eighth day determinations of the pH and for the nitrate, sulfate and fluoride content of the particulates.

3. Eighth day emission spectrographic determinations for metals.

4. Organic fractionation of 60 day pooled samples of the benzene soluble extract.

After reviewing the bid proposals that were received, the contract for the laboratory work was awarded to the Syracuse University Research Institute, with the exception that the emission spectrographic work was arranged through the Division of Laboratories and Research of the Health Department.

Because of the distance that separated the laboratory, which would be in almost daily contact with the network through the submission of samples, from operational headquarters in Albany, it was necessary to arrange for reporting any occurrences that required service. The schedule for replacing the brushes was 500 hours, and this work was to be done by the operators of the equipment. While it was anticipated that the motor units would give about 2000 hours of service, it was not planned to have this done by the operators. Rather, it was proposed to have all motor replacements make in Albany in order that the sampler could be calibrated after the motor was replaced.

In order to replace any sampler that became inoperative, the laboratory reported at frequent intervals by telephone, generally weekly, and advised when a sampler needed to be replaced. This information was reported by the operators on the data cards that accompanied the filters. At other times, the stations reported this information directly, usually by telephone. Replacement samplers, when it became necessary, were shipped by air express, or delivered by Section personnel, depending on the distance involved. The malfunctioning unit, when returned to Albany, was serviced, checked and stored for the time when needed again.

The flow through the samplers was found to vary to a significant degree when the motor units were replaced, and in view of this it was necessary to eliminate this significant source of error. At all times, there was only one flowmeter for each sampler, so that the entire system was considered as a unit, and calibrated accordingly.

From the operating data reported by a station that was in operation for 357 days out of a possible 365, fairly complete records were obtained. During this period the average brush life was 474 hours between replacements and ranged from 250 to 576 hours. Motor life was reported, in two instances, to be 2700 hours and 1600 hours. These experiences were repeated at several other stations, and were considered to be typical. The delivery of brushes to the stations was scheduled at intervals consistent with this experience, in order that a supply was on hand at all times.

Shortly after the network began operation, an administration difficulty developed that required a solution. All of the personnel operating the stations had volunteered their services, and in some cases, only one person was available at a station to do the necessary work. Since this was a daily operation, it placed a burden on the operator's time, particularly during the weekend periods. This problem was resolved by installing duplicate samplers, operated by a timer. (3) As originally purchased, the timer would operate only one sampler. However, these timers were modified internally so that two samplers could be operated consecutively, that is, by setting the trippers on the timer mechanism at the appropriate places, the first sampler would be operated for a 24-hour period, after which it would be shut off and the second sampler started immediately. By this method of operation, personnel attendance was not necessary for one day, usually Sunday. It was essential, however, that the filter on the first sampler be changed before the end of the 48-hour period as otherwise the first sampler would be reactivated, and an improper sample would be collected. It can be reported that this arrangement was completely satisfactory, as there was no difficulty with the timer, proper samples were collected, and the amount of personnel time was reduced.

The operation of the flowmeters was one problem that presented particularly great concern. Since the flow through the sampler was calculated to be the product of the average of the readings at the start and finish of sampling period multiplied by the length of time, any error in readings would be increased many fold. These flowmeters are susceptible to clogging, very likely due to fine particles resulting from the wearing of the carbon brushes. Under normal operation, the flowmeters were not on the line during the sampling run. Rather a short piece of tubing from the sampler was connected to a longer piece from the flowmeter by a metal connector only at the time that a reading was taken. In this way, the probability of these fine particles clogging the flowmeter was reduced to a large extent. However, the most practical solution with this type of equipment was the frequent and periodic cleaning of all of the tubing so that there would be a minimum of particles in the line which would clog the flowmeter.

Since there is this problem with the brushes, an ideal solution would be to have a brushless motor driving the blower but as yet a suitable motor has not been located. A brushless motor, if one were available that was adequate for the service, would also have the advantage of eliminating the need for the periodic replacement of brushes, which in itself is not a serious chore. However, it will happen that brush replacement will occur during a sampling run, and for all practical purposes, the sample is useless since the actual sampling period is unknown. This is a problem that has received our attention without any success to date.

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(3) International Register Company, Chicago, Ill., Model VZ 1003.

In order to keep the operators of the station informed as to the results, arrangements were made to have the laboratory prepare a master ditto at weekly intervals, listing all the analytical results for that period. These results were distributed for informational purposes only, as the results were unevaluated in any form. A system was devised, once the results for the first several months of operation were available, whereby the data was placed on punch cards. This time delay was necessary as there was no previous indication of the range in the data, and this information was needed for card layout. The results could be processed by machine methods and a print-out could be obtained for record purposes as well as be studied to determine any significant relationships.

One of the important relationships was to establish the effect of wind speed and direction on the contaminant levels. As meteorological data for the year of sampling is available from the Weather Records Center at Asheville, North Carolina, it is planned to obtain this data and enter it on the same cards as for the laboratory results in order that this phase of the study can be carried out. It is recognized that there may be a distance separating the official weather station from the location of the sampler, but it is believed that the use of these official weather records will be proper. A field evaluation of each sampling site will be made to determine any significant topographic features and any important pollutional sources.

As a result of the operation of this network, there is a record of analytical data which can yield the information which was sought. While the record for some of the stations is not as complete as one would like, there were 8 stations that submitted 85% or more of the samples for the entire year. Of these stations, 5 submitted 340 or more samples during the sampling year. Overall, a total of 4437 samples out of a possible 5475 were collected and submitted to the laboratory for analysis. This is an indication of the cooperation that was recieved from the station operators.

SUMMARY: The experiences with the operation of the State Air Sampling Network can be summarized as follows:

1. The sampling equipment operated as expected, but improvements are desirable. Average brush life was in the order of 500 hours, and motor life in the order of 2000 hours. However, it was concluded that improvements are needed to this equipment in order to reduce maintenance problems.

2. The data that was obtained from this operation can be used to evaluate the fluctuations in pollutional levels. With detailed statistical analysis along with studies of meteorological data and topography it is expected that significant relationships can be established which will be useful in future operations.

3. There is a background of wide interest in air pollution activities in communities and personnel can be found who will participate in some phases of a program, such as operating sampling equipment.

CHAIRMAN GRUBER: Thank you, Mr. Maneri.

Our next speaker this morning will talk about laboratory support and we have a laboratory man for this assignment, Dr. Helwig who is Chief of the Air and Industrial Hygiene Laboratory of the California State Health Department. Dr. Helwig.

LABORATORY SUPPORT

Harold R. Helwig

DR. HELWIG: I hope there is a subsequent paper for support of the laboratory.

My comments on laboratory support of atmospheric sampling programs will be related to the experience of a state organization which has responsibility for the state-wide coordination of studies of community air pollution. First I will consider the influence of objectives of air sampling programs on laboratory requirements. Then I will attempt to describe in general terms, the role of the laboratory in (1) planning of air sampling programs, (2) laboratory research and development, (3) execution of the sampling program and, (4) evaluation of air sampling data. Finally I will discuss some experiences in organizing a laboratory for a comprehensive air sanitation program and briefly indicate the capabilities of a small laboratory.

OBJECTIVES OF AIR SAMPLING PROGRAMS

Some general objectives of air sampling programs include the following:

1. Long-term studies of trends of community air pollution.
2. Intensive short-term studies of general local community air pollution.
3. Studies of special community problems in air pollution.
4. Studies of the effectiveness of air pollution control programs.

All of these objectives have requirements in common for the laboratory program but general differences can be readily illustrated. In our experience sampling of particulate matter and gas sampling and analysis by automatic instruments have been found applicable to studies of trends of community air pollution. Such a program generates a workload of routine laboratory analysis of particulates and requires a continuing program of calibration and service of automatic analyzers. Intensive short-term studies of community air pollution requires a laboratory prepared to move to the field in order to analyze manually collected samples of gaseous pollutants in addition to analysis of particulate samples, and hydrocarbon samples at a central laboratory. Surveys of special community problems in air pollution are illustrated by studies of the effect on a community of emissions of sawdust burners, agricultural range burning practices, fluoride emissions and sulfite emissions. These may require special analytical methods and field work of the laboratory staff. For the laboratory the studies of the effectiveness of air pollution control programs have many elements of programs to study air pollution trends, although less emphasis may be placed on the use of automatic instruments. An example of such an activity would be the study of the special problem of community air pollution from sulfite emissions and assessment of the pollution levels after institution of recommended controls.

THE ROLE OF THE LABORATORY

Planning of an Air Sampling Program

Two principal questions need to be answered in planning an air sampling program. They are:

1. What pollutants shall be measured? and,
2. How shall the pollutants be measured?

These require the consideration of the engineering, medical, meteorological, statistical and laboratory staffs at the earliest stages of planning. In air pollution problems resulting from a complex mixture of pollutants, the question of what to measure is a difficult one to answer. It is no solution to answer this question by considering what is measurable by methods that are readily available. This is permitting "how" to measure dictate "what" to measure. Although the two questions are interrelated the problem of measuring a pollutant can often be solved if we have the evidence that a specific pollutant should be measured and that expenditure of developmental effort is worthwhile. Here the contribution of the laboratory scientist can be crucial. His study of the pollution problem can contribute to the judgment of what pollutant is important as well as what methodology is required for its measurement. If sulfur dioxide is an important pollutant, then gaseous sulfur dioxide should be measured. If the concentration of proton donors is closely related to the concentration of sulfur dioxide, this can be measured as an indication of sulfur dioxide. If particulate sulfate is determined to be relatable to sulfur dioxide then particulate sulfate analysis may be used to measure sulfur dioxide. These are determinations to which the chemist can contribute.

The question of how to measure a pollutant involves the methodology of collection and analysis. In program planning it is the responsibility of the laboratory to assess the accuracy and precision of available methods and to determine the applicability of adapted and new methods to the sampling problem. Included in the numerous aspects of methodology that the laboratory must evaluate are accuracy, specificity, precision, and sensitivity of analytical methods and the collection efficiency of sampling methods. Final selection of sampling and analytical methods most often is determined by judgment of their adequacy for accomplishing the objectives of the program and the economics of their use. Thus laboratory evaluation of sampling and analytical methodology is vital to the statistical planning of the program.

Laboratory Research and Development

In planning air monitoring programs, establishing objectives, selecting pollutants to be measured and deciding upon methods of collection and analysis it will be the exceptional case which does not reveal a need for adaption of methods, development of new methods or evaluation of existing methods. It is also the exceptional case that a planned sampling program proceeds without the discovery that additional measurements are desirable and that other modifications are needed. It is the fortunate organization that provides for a laboratory staff with research and development interests. Such a staff can minimize the influence of "how to measure" on the "what to measure".

The potential contributions of laboratory research and development to sampling and monitoring programs are illustrated by the following examples. The extent of air monitoring by means of automatic recording analyzers is limited by manpower available to recalibrate the instruments frequently in the laboratory. The laboratory staff can develop methods and apparatus for calibration work at the field sites. Requirements for a sampling network for sulfur dioxide cannot be met because of the limitation of manpower for manual sampling and availability of recording analyzers. The laboratory staff can evaluate the applicability of the lead peroxide candle which requires minimal field work. Particulate loading is determined by weighing high volume filter collections but only a fraction of the samples are programmed for detailed chemical analysis. The laboratory can compare high volume particulate loading with Hemeon spot samples to determine if the spot samples give adequate data for particulate loading and the high volume sampling program may be limited to sampling for detailed chemical analysis. In a program designed to collect high volume particulate samples for determination of benzene soluble organic material there is a desire to obtain data on specific polycyclic hydrocarbons. The laboratory can develop methods for such analysis on composite filter samples. These are but a few examples of how laboratory research and development work can extend the capability of available manpower and increase the scope of the sampling program.

Operation of the Sampling Program

The character of the monitoring and sampling program obviously will determine the most effective use of the laboratory staff. Chemical analyses and emission spectrography at a central laboratory are requirements of a program of atmospheric particulate sampling and analysis. For programs designed to measure gaseous pollutants on a continuous basis with a network of automatic analyzers emphasis is placed on supply of chemical reagents and the calibration of recording analyzers. Because such a program may involve integration with networks operated by other agencies, an important function of the laboratory is assistance to these agencies in calibration of instruments and standardization of methods to insure uniformity of performance. In programs for extensive surveys of community air pollution and studies of special localized problems the requirements for laboratory support involve participation of the staff chemical analysis in the field with central laboratory support or the use of a mobile laboratory. It should be emphasized that the best contribution that the laboratory staff can make to assure the collection of reliable data in studies using analytical methods in the field is participation in the field operation. It should be further emphasized that laboratory staffing should provide adequately for this participation.

Evaluation of Data

If proper planning of the sampling program has been done the laboratory will have made most of its basic contribution to the evaluation of data during the planning phase. The laboratory will have evaluated sampling and analytical methods to be used and these evaluations will have been considered in the statistical design of the program. However, during the operation of a program the laboratory accumulates data and experience upon which to base a re-appraisal of methods that may have a bearing on data evaluation. The laboratory should take advantage of this opportunity to re-evaluate the capabilities of methods in use.

LABORATORY SUPPORT OF STATEWIDE SAMPLING PROGRAMS

The foregoing remarks have been in an attempt to point out, in general terms, the scope of laboratory support of sampling programs. In contrast to the limited view that laboratory support consists of central laboratory analysis of atmospheric samples, it has been emphasized here that laboratory support involves contribution of laboratory staff to every phase of the program from planning through execution and data evaluation. To illustrate the support functions of a laboratory and the magnitude of the laboratory task some experiences in state programs will be briefly described.

In California one of the state responsibilities is the study of trends of community air pollution. One phase of this study is the operation of a sampling network for the collection of particulate samples and the determination of total particulate material, sulfate, nitrate and benzene soluble organic content. Local agencies assist in the periodic collection of the filter samples. The state laboratory performs the analysis. An average of fifteen samples are collected per week from a network of twelve sampling locations. One analytical chemist can handle the workload of thirty samples per week. Periodic sampling in the network is done for the collection and analysis of particulates for metals including: lead, zinc, vanadium and chromium. It should be emphasized that the objectives of metal sampling were twofold, namely, determination of trends of particulate metal concentrations and the accurate determination of concentration of metals in air for the medical program in air pollution. Laboratory contribution to method development is well illustrated in this connection. Investigation showed that the metal content of clean glass filters was variable and that this filter material was unsatisfactory for the collection of samples for spectrographic analysis of metals with the desired accuracy. It was found that a cellulose paper had negligible content of the metals of interest and could be used on high volume samplers for the collection of twenty-four hour samples which contained sufficient metal for spectrographic analysis on 2 milligrams of ash with an accuracy of sixteen percent.

A second phase of the study of air pollution trends is sampling of gaseous pollutants. A network for manually sampling total oxidant once daily at fifteen sites is operated with the cooperation of local Health Departments and is coordinated with a similar network in the Bay Area Air Pollution Control District. The laboratory support consists of standardization of the phenolphthalin reagent and the colorimeters used in the network. Standard solutions of phenolphthalin, developed by the Bay Area District Staff, are mailed to cooperating agencies which analyze them and report the results. In this way frequent intercomparison of colorimeter response is accomplished and field work of the laboratory staff is reduced to that required to introduce the method to an agency at the beginning of its cooperative effort in the network and to assist with problems upon request. The sampling network for gaseous pollutants also includes automatic recording analyzers operated at ten locations by the state and numerous instruments operated by air pollution control districts. The instruments in use sample for carbon monoxide, sulfur dioxide, oxidant and nitrogen oxides. All the sampling stations operated by the state have oxidant analyzers and one or more of the other analyzers. Laboratory support of this operation requires chemical calibration of the analyzers before locating them in the field and frequent recalibration at the sampling sites. A field section of four chemists has the following responsibilities: 1, calibration of the manual sampling network for total oxidant; 2, calibration of the state-operated recording analyzers; 3, assistance to local air pollution control districts in the calibration of recording analyzers and, 4, development of improved methods for calibration of recording analyzers. As the local air pollution control districts develop trained staff and laboratory facilities the need for assistance decreases only to be replaced by the need for assistance to those agencies which are beginning air sampling programs. Development of improved methods for calibration increases the capacity of the field section to serve the expanding monitoring network and is an important task of the field section.

Technical assistance to local agencies is but one aspect of the laboratory staff activity directed toward uniformity of operation of the monitoring network. Control districts operate monitoring networks for objective that differ from the objective of the surveillance of air pollution trends on a statewide basis. By proper coordination the monitoring efforts of state and local agencies can supply data for both the local and statewide objectives. Advances in methodology of sampling, analysis and calibration of instrumentation are constantly being made by the agencies engaged in air pollution studies. To promote the understanding of objectives and the exchange of information on such topics as analytical methods, methods of sampling and calibration techniques, the laboratory arranges conferences at which technical staffs of the various agencies present papers on their work and discuss technical problems. Another important related activity of the laboratory with the assistance of local agencies, is the compilation of standard methods for the sampling and analysis of air pollutants and for the calibration of automatic recording analyzers. These activities require the participation of our entire staff.

Intensive short-term surveys of air pollution of a local community and field studies of special problems present the most varied problems for the laboratory. Shall the survey be conducted with field analytical methods or with a mobile laboratory or shall samples be transmitted to the central laboratory? Is weight loss on ignition of filter samples adequate for the assessment of sawdust loading or is measurement of reducing substances in the acid hydrolysate of the sample required? Can nitric oxide be measured as nitrogen dioxide by sampling with an impinger with Saltzman reagent with a bubbler of permanganate in the sampling line? Should hydrocarbon samples collected by freeze-out be returned to the laboratory at the end of a field study or be analyzed immediately? These and other questions need to be answered in the planning of field studies. Adequate staffing of the laboratory has been planned so that at least one chemist can be a part of the field team engaged in surveys of community pollution problems. The use of a mobile laboratory is generally a distinct advantage if local laboratory facilities are not readily available.

The development of a laboratory program devoted to air pollution studies may be of interest to those contemplating such an activity. In 1956, the California State Department of Public Health organized an Air Sanitation Laboratory as a member of a team of medical, engineering, meteorological and statistical personnel. The immediate objective involving the laboratory was air monitoring for the evaluation of trends of community air pollution throughout the state. The initial laboratory staff included a chief of the laboratory and three analytical chemists. The principal activities of this staff were analysis of particulate samples collected by high volume samplers at twelve sites, calibration of six automatic recording analyzers and standardization of a manual oxidant sampling network of six stations. Local Health Departments and other agencies operated most of the sampling stations. This staff was minimal for the operation of the high volume particulate sampling program and the oxidant measurement program. Limited sampling programs for intensive surveys of community pollution and study of special local problems with available methods were carried out. Studies requiring development of methods and the proper maintenance of function of automatic analyzers were not possible with the limited staff.

It would be difficult to follow the expansion of laboratory staff and relate it to expansion of the sampling programs. In 1956, three chemists were added and the particulate sampling program and the network of automatic analyzers were extended. By 1958, the staff included nine chemists and in 1959 fifteen positions are budgeted for the air pollution program. During these years several significant changes have been made in laboratory program. Laboratory research and development has been emphasized and expanded to meet the need for improved methods. The Staff now has the techniques for calibration of recording instruments at field locations and spends considerable time in calibration work in the field at remote locations and in assistance to local agencies. The chemists now participate in sampling studies in the field with a mobile laboratory facility or use laboratory facilities in the local community. Establishment of recommended methods for air sampling and analysis and for calibration of recording instruments represent staff time well spent on an effort which is helpful to personnel beginning work in air pollution and encourages uniformity of methods used in sampling networks.

An inventory of the present staffing of the laboratory and its relation to the air sanitation program may be instructive. The present budgeted staff of twenty-one chemists is related to two programs of the department, namely air pollution and industrial hygiene. Fifteen chemists are budgeted for air pollution activities and those assigned full time to the program are indicated by the numbers in parenthesis in the attached organization chart.

The five chemists in the Research Section are assigned full time to air pollution problems. Three chemists in the anlytical section are assigned to analytical work from the particulate sampling network and to field studies for survey of general community problems and special local problems. The field section of four chemists is engaged in work in the sampling network of automatic recording instruments and the manual oxidant sampling network which includes extensive work with local air pollution control districts and Health Departments. The Instrumentation Section analyzes metals in air spectrographically and infrared analysis of hydrocarbons in air in the sampling network program in addition to the physiochemical instrumentation work related to other aspects of the air pollution program. This represents the laboratory staffing planned for sampling network activities which include filter particulate samples at the rate of fifteen samples per week, operation of a sampling network for oxidants in collaboration with twelve local Health Departments, and operation of a network of automatic recording analyzers at ten locations.

A BEGINNING LABORATORY PROGRAM

The description of laboratory organization and activities which are related to varied and rapidly expanding environmental and medical air pollution studies on a statewide scale may not be very instructive to those interested in beginning a laboratory program in support of air monitoring and sampling programs. Let us assume that they will begin without the benefit of existing laboratory facilities with the objective of supporting a long-term monitoring program to determine air pollution trends and a sampling and analysis program to assess localized problems in a county. What generalities can be drawn for a minimal beginning laboratory program?

Staffing may begin with a single chemist but it is a general observation that satisfactory continuity of program is seldom achieved with a one-man laboratory. It can be safely assumed that one chemist is well occupied with planning, devising and improvising. These activities are inherent in air pollution work. If he is given two assistant chemists there will be continuity of activity in the central laboratory, the necessary verification of sampling and analysis methods and the essential participation of the staff in field sampling and analysis.

The necessary central laboratory facilities include a general analytical chemistry laboratory, utilities, and a chemical hood. Major equipment will include an analytical balance and a spectrophotometer.

From the methods already developed for monitoring air pollution trends we can choose the high volume filter sampler. Total particulate loading by weighing may be a satisfactory beginning. Dustfall determinations are a more economical substitute. Hemeon samplers at greater cost give more detailed information on diurnal variation of particulate loading. High volume samples can be subjected to more detailed analysis such as extraction of organic material and analysis of inorganic ions.

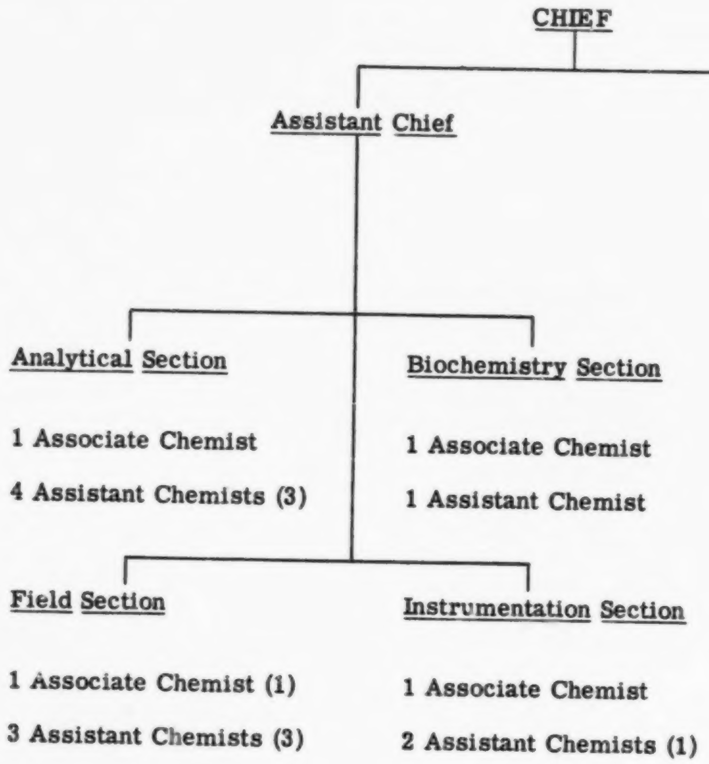
The arsenal of methods for sampling and analysis of gaseous pollutants with the facilities of this minimal laboratory is now extensive. A portable vacuum pump, collection bubblers, manometer flow meters and a spectrophotometer make possible sampling and analysis for oxidant, nitrogen oxides, sulfur dioxide, hydrogen sulfide, aldehydes, mercaptans and many other pollutants. The application of these methods for sampling and analysis of gaseous pollutants and high volume particulate sampling will make a good beginning of a program to assess localized problems. By improvization much of the analysis can be done in the field.

The capabilities of this minimal laboratory facility with a staff of three chemists will be limited mainly by manpower available for field work. It is discussed here to indicate the laboratory nucleus that will give creditable initial support for an air monitoring and sampling program. It will serve also as a basis for expansion of support activities that will be required for more definitive air pollution studies and the more comprehensive program that will develop.

SUMMARY

Some important contributions of a laboratory to the planning, development of sampling and measurement techniques, operation and data evaluation in relation to air sampling and monitoring programs have been outlined. The laboratory requirements for an extensive and varied state-wide program coordinated with the efforts of cooperating agencies has been described. The capabilities of a minimal laboratory for a beginning program in air monitoring and sampling have been briefly outlined (Table 1).

TABLE 1. ORGANIZATION OF THE AIR AND INDUSTRIAL HYGIENE LABORATORY CALIFORNIA STATE DEPARTMENT OF PUBLIC HEALTH


CHIEF
Assistant Chief
Research Section
3 Research Chemists (3)
2 Assistant Chemists (2)
Analytical Section
1 Associate Chemist
4 Assistant Chemists (3)
Biochemistry Section
1 Associate Chemist
1 Assistant Chemist
Field Section
1 Associate Chemist (1)
3 Assistant Chemists (3)
Instrumentation Section
1 Associate Chemist
2 Assistant Chemists (1)

CHAIRMAN GRUBER: Well, gentlemen, there was much substance in both of these papers by the men who were in on their programs from the beginning. Are there any questions or discussion?

MR. GARLAND: I would like to ask Mr. Maneri what sort of an arrangement you made on flowmeters in regard to hindrance of operation by moisture and freezing and temperature and so forth. What type of flowmeters did you use, or how did you overcome those difficulties?

MR. MANERI: Well, we used the flowmeters that came with the high volume air sampler. That was a rotometer. Actually our flowmeter was attached to the under part of the roof of the sampler housing. To our knowledge, not too much difficulty was reported with the moisture or freezing. As a matter of fact, the first time it came to our attention was just last week. During the operation of the state network, it didn't come to our attention at all.

One thing we stress with the operators at all times was that they were not to touch that flowmeter in any way at all. If they did, we pulled the sampler back and recalibrated it.

CHAIRMAN GRUBER: I think that attention to detail and calibration, is really one of tremendous importance in a sampling program. You roll out the data day after day, and an error in calibration or some procedure is hard to find particularly when volunteers operate this equipment.

MR. KOCH: You just mentioned before that frequent cleaning and measuring only at the beginning and end of the run with the flowmeter was essential. Then in answering this gentleman's question, you say leave it alone. Now, who is going to do the cleaning and who is going to do the measuring in the beginning and end?

MR. MANERI: No, when I said frequent cleaning, it was of the Tygon tubing and not of the meters. The operators did that.

MR. KOCH: You said leave the meter alone.

MR. MANERI: Not to play around with the meter, not to try any adjustments with it, not to actually try and clean the meter itself. We had some attempts at that and they were unsuccessful. The meter itself was actually -- well, we just didn't want them to play with it at all.

MR. TABOR: I would like to make one comment in connection with the flowmeter problem. We have recommended for some time that these flowmeters be kept inside a building and not left exposed to the weather, because our samplers are exposed from 110 degree temperatures to below zero, and they do get moisture in them. Our current practice is to recommend that they be used for measuring the flow at the beginning and at the end, and not left connected to the sampler.

Cleaning the flowmeter is quite a problem and we usually recommend that it be returned to us for cleaning.

MR. SMITH: Two questions, actually. I would like to ask Mr. Maneri what system he is using for pollen. Is it a volumetric system or the old slide system; and secondly, if I understood you correctly, you indicated that you tried to sample in excess of 300 days a year at your sampling stations. Now, I wonder if you have analyzed your frequency distribution and come to any conclusions re the precision of this measurement and how many samples you really require at a station to obtain a desired precision?

MR. MANERI: Well, in answer to the first question, we use the Durham sampler. That's the slide sampler. We know there are limitations with it, but at the present time it is the best sampler available. We hope some of the work that is being done out of Michigan will provide us with better samplers and sampling techniques.

In answer to your second question, we suffered with growing pains with this network. One of the big problems was to set up some kind of method of treating this data, and as yet we haven't done this work. This week we are beginning analysis of the data and that is one of the things we hope will come out of this data. One thing we want to check is actually at what intervals can we sample and still get representative results -- we just don't know yet, but that's one of the things we hope to get. It hasn't been done yet, but we hope it will be done.

CHAIRMAN GRUBER: Mr. Stern.

MR. STERN: In the list of substances Dr. Helwig listed as being measured automatically, I noted the absence of CO_2. Since this is something that I noted was being measured automatically in preference to other substances in several European cities, I wondered what his experience and opinion is on CO_2 as an automatic measure of air pollution.

DR. HELWIG: I have no experience and have no opinion. What is the background for measuring CO_2? Is it for the purpose of measuring urban activity as an indicator of pollution potential?

MR. STERN: Urban diurnal variations on a day to-day basis.

DR. HELWIG: I consider this as information that should be taken back to our department for consideration.

MR. FRENCH: I noticed in Dr. Helwig's paper, as well as other papers that have been presented by California people, that your whole organization is set up on the basis that the chemists apparently do the field work. Is this correct and, if so, I just wonder how this happened to come about? Is this your answer to the engineering shortage?

DR. HELWIG: No, the chemists do not do all the field work. My emphasis was that in studies where field analysis, involving taking analytical methods to the field, is done, we find that the participation of the chemist in the field studies is highly desirable. Most of the work of sampling is done by the local agencies, and includes routine sampling, the daily operation of the automatic recorders in the gas sampling network and in the manual sampling for oxidant. This is done by the local volunteers generally in health agencies and in the air pollution control districts.

The key thing that the chemist is expected to do is to see that the calibration of the recording instruments and of the colorimeters in the oxidant network is properly carried out. This may involve a one-time visit to start the station, and a system of followup as in the oxidant network where we use the phenolphthalin reagent and colorimeters that belong to local agencies. A check is made by sending a standard solution, which is quite reproducable, to the operators in the local agencies, have them read it and return their data. This gives a check on the performance of the colorimeter. At least we hope that they remember the pointers in the sampling process after having been shown them at the beginning of their cooperative effort.

If a personnel change occurs in the local Health Department and a new person takes over oxidant analysis, we will visit the agency, if necessary, and assist with training in the sampling procedure.

As the local districts develop their laboratories and can do the calibration of automatic recorders, they do so. It is generally our experience that local districts start off without laboratory staff and without laboratory facilities in the first year or so. It is their instruments that we will calibrate in the field and their staff that we assist in calibration work.

MR. FRENCH: Well, then, by servicing the equipment you did not have reference to changes of brushes and motors, strictly laboratory services?

DR. HELWIG: Yes. Wherever the calibration requires a chemical calibration, the laboratory sees that this is carried out, and it encourages uniform methodology for doing this. One way to accomplish this is to have these people together in conference from time to time for an exchange of information. Staffs of local districts do a very good job of developing new techniques. We have a chance to bring them together and hear about their new advances, their new techniques, and to incorporate these into a compilation of standard methods for the purposes. This gives them some feeling that they have made a contribution to this effort, and they have actually made many real contributions to the standardization of methodology.

MR. SCHREIBEIS: Have any particle size determinations been made on high volume samples that are collected in New York or California?

MR. MANERI: In New York we did not. Since our laboratory work was done by contract, we were limited to just the work that was specified in the contract. We just didn't have the flexibility we would have liked.

DR. HELWIG: We have done no particle sizing on high volume filter samples. However, our interest is very high on particle sizing and analysis, and one of our research projects in this connection is the use of the Goetz aerosol spectrometer to assess particle sizes.

MR. HYDE: Dr. Helwig, I don't recall that you mentioned anything about the use of dustfall cans. Do you do any of that work and, if you do, do you find any correlation at all between that work and the high volume samplers?

DR. HELWIG: We do make some dustfall measurements. It is not an extensive program or a continuing one. The correlations I do not know about. Maybe Frank Bell does.

CHAIRMAN GRUBER: There is no correlation whatsoever. You would not expect any because high winds pick up surface dusts that often result in high dust fall while high winds disperse fine particles. So when you expect high dustfall, you could expect low high-volume collection.

I would like to ask a question and this is directed to Dr. Helwig -- you are given a problem of measuring two gaseous materials to indicate, one, the raw automotive exhaust in your community and, two, the effect of photochemical smog reaction. What would you measure on a continuing automatic monitoring program?

DR. HELWIG: There has been some thought that carbon monoxide should be an indicator of auto exhaust. There is some contradictory information about its effectiveness. I would think that this gaseous pollutant might at the present time be the one of choice. For your other question, regarding plant damaging materials and eye irritants, we, of course, don't know the phytotoxicant or the eye irritant. It has been the thinking that the photochemical smog oxidant is the best index we have at the present time. We know that this doesn't always correlate the phenomena of eye irritation and plant damage, but it is the pollutant that most often correlates with these phenomena.

CHAIRMAN GRUBER: That has been our conclusion also.

MR. TABOR: Dr. Helwig. Have you been able to correlate your lead levels with the traffic density in some of your studies?

DR. HELWIG: Lead level measurements have been generally very sporadic and of short duration such as short sampling periods a couple of times a year. I haven't looked at a correlation. The only thing I know is that downtown areas and high traffic density do generally have higher lead, but whether this is of significance in actual assessment of long-term trends I do not know.

I think the National Air Sampling Network data doesn't show a trend in lead levels over the period reported, '54 to '57. Is that right?

MR. TABOR: That's right.

DR. HELWIG: No trend that you might expect with increased auto traffic.

CHAIRMAN GRUBER: Can I advance one more question? On automotive exhaust; where would you sample?

DR. HELWIG: In looking for the maximum conditions and being interested in what people are actually exposed to, we want to go to the area of maximum traffic density and probably not sample higher than where people generally are. This would be rather near a street level in an area of high traffic density.

CHAIRMAN GRUBER: You mean that would be within, say, not over 15 feet above the ground?

DR. HELWIG: Yes.

CHAIRMAN GRUBER: Now, Art.

MR. STERN: Mr. Maneri, you mentioned that your data are going on to cards and that you are starting data analysis. I wonder if your format of punch cards is compatible with that used for punching here so that the cards are interchangeable?

MR. MANERI: Yes. Actually, before we set up our card system, we had Mr. Tabor come to Albany and we tried as nearly as possible to match the two. There were some minor differences but we understand they are not in any great conflict with the system used here in Cincinnati.

CHAIRMAN GRUBER: Questions? Anybody have anything to add? Ray Smith.

MR. SMITH: I would like to know if either of you have made any endeavor to correlate the sulfur dioxide values obtained by the use of lead peroxide candles with those obtained by other procedures and I similarly wonder if, in view of the proposed increase in the tetraethyl lead content of gasoline, you intend to do any before and after studies to ascertain what difference this will make in street concentrations of lead.

DR. HELWIG: We have not had a chance to evaluate the lead candle versus a gaseous sampling method. However, the Taft Center has done the field work for such a study, and I don't know if the data has been analyzed yet from that network in which a manual sampling network for gaseous sulfur dioxide was superimposed on the lead candle network. Maybe someone can answer that question at the moment.

MR. SCHUENEMAN: We haven't finished looking at the data from our Nashville study as yet. We have made measurements, but we haven't looked to see what the relationship is. In the "Atmospheric Pollution in Leicester" they say that the milligrams report of sulfur trioxide per 100 sq. cm. per day multiplied by 0.025 will give a rough estimate of sulfur dioxide in ppm by volume.

DR. HELWIG: Well, we will all be waiting with interest for data from this very dense network that the Taft Center has set up and is evaluating. The lead question has raised a lot of interest in California, both because of the increase that is expected in tetraethyl lead content of gasoline and due to the recent change for the department to set standards for auto exhaust. In this connection lead is very important and, at the present time, is not being included in the standard. The reason for not including it is the need for more work, and no doubt we will be the ones to do it. We have not started any program in lead, but an intensive one is being planned.

MR. STERN: We have received instructions to increase our work on the relationship between lead and traffic. Therefore we will be starting intensive work in this area and will be opening discussions shortly with the several state laboratories to do this cooperatively.

CHAIRMAN GRUBER: Would anyone have any matters they wish to present on any of the discussions, not particularly questions?

MR. SCHUENEMAN: I wonder if anyone has discovered a good, trouble-free method of providing a uniform airflow rate through filters over a long time period in the range of, say, one to five liters a minute through a one inch diameter filter paper? The flow does fall off as you sample. I wonder if anyone has found a good way to get a constant flow over a 24 hour sampling period.

CHAIRMAN GRUBER: You mean a device of some kind? Is that what you want?

MR. SCHUENEMAN: Yes.

CHAIRMAN GRUBER: All right. That's a challenge. Who has found it?

MR. SCHUENEMAN: We have used critical orifices and find they plug up even though we place filter papers in front of them in the flow system.

CHAIRMAN GRUBER: I would like to pursue the matter I raised yesterday on the high volume sampler if we are measuring, long-time trends. Why don't we go to a month long sample period at a reduced flow rate which will, therefore pick up all the meteorological variabilities in the month and we would wind up with 12 samples a year for one sampling station.

MR. MANERI: I have here one report sheet that we sent out to the station operators. If you look at the data here, you find tremendous differences from day to day. Just picking out numbers from random from this table, on one day the particulate concentration is 73 micrograms per cubic meter. The next day, 176. Then 97.5. Actually, if you had a monthly sample, how could you apportion the load on each day and come up with a reasonable conclusion? We do have these tremendous differences in wind directional speed. Those apparently, we believe, affect these results. If you lump them altogether, I don't believe you can come up with any definite conclusions.

MR. SMITH: Well, really, doesn't this go back to why are you sampling. I think for the purpose that you state as being your reason for sampling; namely, nothing more than long term trend, you want to know some kind of a yearly average at a given station. As far as I am concerned, there is no reason why you can't use a one month sample for this purpose.

However, if you are interested primarily in peaks for weather correlation as we are in Philadelphia where we are trying to use this as an index of natural ventilation rates, you have a second purpose for sampling which clashes with the method used to accomplish your first purpose.

CHAIRMAN GRUBER: All right. That's a point I want to bring out. We know that these variations from day to day do exist. Why don't you use the AISI sampler or strip sampler to give the information you want on ventilation rate, and you take your high volume sampler for particulate loading for long-time trend?

MR. SMITH: There are two reasons why we don't do this - both of which may be wrong. We use AISI samplers, but the reason that we would not be interested in them for this purpose is because we are trying to find out how much dust is in the air on a total loading basis.

Maybe you know, but I don't know of any good correlating figures that exist between Coh and micrograms/M^3.

Now, the other reason we don't do this is again what are you sampling for. Now, I said peaks. I am not so interested in a two-hour peak during the day because I have no real idea of what significance this may ultimately have on community health. I do have some information that indicates that a peak concentration lasting over a day or several days may certainly cause certain types of problems in the community. If I were interested in the very brief peaks, then I would probably use the AISI sampler. However, I am interested in the daily peaks or three or four day peaks.

CHAIRMAN GRUBER: Who else has an idea on this?

MR. DOUGHTY: It was mentioned yesterday that when you use this low volume sampler, the AISI, in certain heavy fallout areas you get very little pickup, and it has been our experience further that in the heavy fallout area this tape may even be clean as compared to some of our cleaner areas, whereas a regular high volume sampler would tend to be just exactly opposite, so this would throw you a nice curve, too.

CHAIRMAN GRUBER: I would like to know your definition of clean in this reference.

MR. DOUGHTY: Actually what I have reference to here is that spot density of the paper in this area would not necessarily be as dirty as the rest of the fallout would indicate. In other areas where we figure to have quite a bit less fallout, let's say more from the standpoint of downtown where we have steam lines and no smoke or anything like that to speak of, we would get quite a bit darker or more dense paper or readings than we would out in the dirty area.

CHAIRMAN GRUBER: Let me ask you this: If you had a house and were worried about the dirt on curtains, walls, or the dirt on your shirt collar, which would give you the better index of cleanliness, a high volume or AISI sampler?

MR. DOUGHTY: We would get a heavier reading or dirtier reading with the high volume than AISI: That's what we found.

MR. TABOR: I might make a comment or two. When we think about the particulate loading, tend to consider that, as far as the health aspects are concerned, to be chronic rather than acute. You are looking for acute effects when you are looking for peaks.

Another point is that we have made some statistical analyses of some of the sampling data, comparing 26 samples a year against daily samples, and we found very good correlation, and that perhaps will be covered in a later discussion.

I also want to mention that for the past year we have been doing exactly the thing that you suggest, and that is collecting monthly samples using a millipore filter and a positive displacement, constant flow pump. We will be able to make some comparisons at the end of two or three more months sampling. This would represent continuous sampling on a monthly basis.

MR. BELL: Some of the short term sampling programs which I have participated in -- take, for instance, in Phoenix, Arizona. Speaking here of the AISI sampling as it compares to the high volume, when we attempted to compare these, taking an average AISI data for a day, compared with the high volume for a day, pretty good agreement was found. I have seen it in several places. The only place I found it wasn't in good agreement was in a sampling program in Tuscon, Arizona, on a day when we had high winds. On this day we had a high, high volume result, but it was not darker. It was light sandy, and we had a very low AISI result. Therefore, it is important to compare these on the same time basis, taking into account meteorological variables. The comparison was made by overlay plats of AISI data against high volume values.

MR. SMITH: First of all, we have tried the same correlation and obtained negative results.

I didn't want to comment on this question of how many samples do you take, but I feel I am compelled to now. We know that if we take in excess of 300 samples a year, with the frequency distributions that we get in our community, this will give us a result at the 95 per cent confidence limits, on the order of our average plus or minus 5 micrograms per cubic meter. We know if we take 50 samples a year, we get an average plus or minus some 20 micrograms per cubic meter. You know from your own work in various areas, if you take 26 samples per year, that the precision of the result similarly goes down. Then we try to compare results from year to year and station to station. Let's forget the network for a moment and talk about Philadelphia.

If I want to say that a change of 10 micrograms per cubic meter per year on the average at a given station is significant, how am I going to do this with 26 samples a year when the precision of the result isn't there? Similarly, we have taken a number of samplers, vertical samplers as well as horizontal samplers, and run them together in a room where we thought we could at least control the direction in which the air was presented to the instrument. Under these circumstances, we find that there is a rather interesting discrepancy between the instruments which were calibrated before and after each run. We feel that the instrument lacks a certain degree of precision to begin with. This lack has never been accurately defined in the literature. We then try to use these results in a comparison of year to year or area to area within a city. The fact you happened, in certain calculations using Philadelphia data, to come up with fairly close agreement numerically between 330 sample and a 52 sample average to me was completely incidental if it didn't lay full stress on the precision of the result and I don't believe it did. I don't believe you can tell these differences unless you take sufficient samples.

MR. SCHREIBEIS: I want to reply to Frank Bell's comment. In Pittsburgh we have compared high volume results on 60 samples with the AISI sampler, and there just isn't any correlation between the two.

CHAIRMAN GRUBER: Are we ahead of ourselves? This probably should be covered in our next two papers. Could we get our questions and discussion back to laboratory and instruments.

MR. BELL: I have a comment I want to make concerning an earlier comment by you, Charlie, concerning the location of the carbon monoxide and the oxidant sampling stations, and I think I agree with Harold Helwig in general. However, one caution I would like to make in this regard, he said it should be located near a section of town of high traffic density and within, say, 15 feet of the ground level.

Well, I think we need to consider one other thing there and that's to be cautious about getting the sampler located so close to the source that we are just sampling, so to speak, the auto exhaust itself. In other words, we need to have enough dispersion to say we are sampling the community atmosphere.

One thing that may give the rest of you knowledge, something Harold and I know, and that is that the main sampling station of the California Department of Public Health is located something like this, and it is surrounded by an experimental plot about 150 feet from the nearest roadway. My comment further would be if you are downtown and don't have an experimental plot with a vacant lot around it, perhaps you should go a little higher to get a little dispersion.

CHAIRMAN GRUBER: Thank you very much, Frank.

MR. CHALKER: I am a little confused with the last couple of remarks on what the purpose is of taking these lead samples. It seems to me that if you go into the dense section of the town and recognize you want to try to locate where the high concentrations are and if you are after determining the concentrations these people are subjected to and breathe, why should you go any higher than five feet above the sidewalk?

CHAIRMAN GRUBER: You mentioned lead. We are not talking about lead.

MR. CHALKER: The same remark applies to sampling for carbon monoxide.

MR. BELL: I would say this is true, but people don't stand around on the street all the time. You have to get something that's a little more representative of the dispersion they may be exposed to, if you see what I mean.

MR. KOCH: I think emphasis needs to be placed on the exposure time of the people to this concentration rather than go out and get some dispersion in X location which doesn't represent a direct exposure or the absence of an exposure either. I mean, you have to measure it where it occurs, and then apply a time factor to the people themselves for measurement of exposure.

MR. MUNROE: I wonder if what we are saying here is that there is a distinction between dose and rate. What you proposed earlier was essentially a 30 day dose. If we look to gases as some indication of the difference between rate and dose, those of us who have used the autometer measuring sulfur dioxide realize that people are responding to the insult of very short term high level rates. It is not unusual to sample for 30 days near a continuous sulfur dioxide emission source and find that for only five or six minutes out of 30 days do you exceed a level of three or four parts per million. It is this relatively short period of time to which the public is responding and forming impressions which are lasting.

In our discussion here, are we talking about measuring dosages or rates, either for people or for things. If we were to measure sulfur dioxide with a one hour wet collected sample, we might very well conclude that there is no problem because it would be at a low integrated level and even if we sampled constantly for thirty days we might very well come up with the answer that there is no problem.

CHAIRMAN GRUBER: There is no question about the importance of dose and dose rates. Are you looking for the maximum from a localized source such as a partucular traffic corner, or do you want to get the general influence of all of the downtown traffic and want to avoid that specific high density traffic source? That's the same thing we talked about yesterday in selecting the sampling site. Do you want to get the influence of the local source or don't you?

MR. BELL: Well, the personal experience that made me think of this particular point, was in the Bay Area Control District where they located a CO machine automatic recorder towards a parking lot, pretty close to the ground level. Well, this thing would record a certain level which would seem to be perfectly steady until a car came by. and then it would shoot up and come right back down. Eventually they moved it to a little higher location to obtain steadier operation. Whether this was wise or not, perhaps time will tell. I don't know, but this does present a point on erratic operation that you might seem to get from street level location.

CHAIRMAN GRUBER: Dr. Helwig, you started off on this. Do you have anything to add in rebuttal? I think we are approaching the closing time.

DR. HELWIG: Well, in summary, each time you go into a problem, you get back to the basic problem of what are we sampling for, and this varies with each program. Then it is full of compromises because we cooperate with different people who have different basic objectives and, out of the overall, we often want to get data useable for at least two different objectives. There is this compromise that occurs and sometimes it is not at all too bad.

It is also brought out that under most circumstances of sampling and analyses, there is a necessity for checking and validating that the method in the hands of the people using it gives the same results as reported by others. It is a simple thing to analyze for nitrogen oxides by manual sampling with a bubbler. This can be turned over to someone else with the explicit instructions that the flow rate is, say, a liter per minute. There are people who decided that a flow rate of two liters per minute is better and shorten the sampling time. So these compromises will be made that are very detrimental to the sampling process and must be avoided.

We may have a set of samplers fabricated by a glass blower that have been checked out in the laboratory, and found to be satisfactory. Upon reorder of this apparatus there may be slight but important changes in characteristics of the new product. Unless these are checked out, our sampling data will be erroneous. There is that need for constant vigilance of checking equipment and analyses in the hand of the operator and not taking it for granted.

(Brief Recess)

CHAIRMAN GRUBER: The next two papers are devoted to data handling and reporting, followed by data analysis.

The first paper on Data Handling and Processing will be given by Mr. V.R. Hanson, Assistant Chief of the National Air Sampling Network.

DATA HANDLING AND REPORTING

V. R. Hanson

MR. HANSON: Before getting into the subject material, I would like to comment on Mr. Maneri's statement about the sampling station they have at a museum. We have loaned New York a few pieces of equipment now and then, but we didn't know that they might be displayed as museum pieces.

The intent of this presentation is to describe National Air Sampling Network data handling procedures and to discuss some of the considerations associated with automated data processing. We will touch on a few things we have learned through our experience in this phase of our air surveillance operation. Statistical analysis of the data will not be covered, however, because this will be discussed in a subsequent presentation.

As is common to most endeavors that must keep pace with changing conditions, we have had to institute many revisions during the Network's history. Each change in operating procedure has usually required a companion alteration in the data processing system. However, after many trials and errors, there is emerging a versatile data handling and reduction program that will produce results commensurate with program objectives.

In establishing an efficient data handling system, we believe the first step should be to seek the counsel of a competent statistical analyst. He can provide guidance on the selection of data elements that will provide information necessary for furthering program objectives. This will help to insure quality results and will eliminate a lot of uninteresting work associated with correcting errors in original planning.

In keeping with the objectives of our Network, the sampling data should tell us something about the nature and amount of air pollution throughout the nation. We also should be able to detect trends in pollution with respect to time. The data should reveal relationships that may exist between pollution and variables such as population density, industrial activity, climate, geographic location, topography, and meteorological conditions. Use of the data in epidemiological studies has also been anticipated. With the foregoing factors in mind, we have tried to design a data processing system capable of producing information necessary for satisfying program objectives.

For handling the large mass of data collected through the Network, we have found it expedient to employ electronic computer techniques. Through the use of a punched card system of data storage, we can quite readily extract selected portions of data for statistical analysis. Data transferred to punched cards are first recorded in coded form on laboratory file cards containing pertinent basic data from the field and laboratory. Coded data should be placed on the file card in the same sequence in which it will be transferred to the punched card. Thus, the data in the first column of the file card should be inserted in Column 1 of the punched card. This will minimize punching time and also help reduce errors in data transfer. Our laboratory file cards are sent to the data processing section every two weeks for data transfer. By doing this on a regular schedule, the key punch operators can plan their work load in advance and thus improve operating efficiency.

In an automated data processing system, careful handling and storage of punched cards are mandatory for efficient operation. There is probably nothing more frustrating to a computer operator than trying to get good output data from input cards that are physically unfit for machine operation. Damaged cards can increase computer costs far above expenses incurred by having given the cards proper care in the first place. One of the easiest way to insure well preserved decks is to store them under lock and key in commercially available cabinets specifically designed for this purpose. If certain elements of punched data are frequently used for sub-routines of a basic program, it may be advisable to maintain duplicate card decks and to keep one in reserve for use when running only the complete, basic program. By so doing, the latter deck will not deteriorate rapidly and can be used for reproduction of new decks when necessary. In addition to providing good storage facilities, it is important that cards be well protected when transporting them to the computer, particularly if this involves carrying them out of doors. Procuring a few metal carrying cases with good safety locks is much less costly than spilling cards from a cardboard box in a rainstorm.

To insure accurate transfer to data from file to punched cards, the latter always should be verified. This involves having the cards punched twice in succession by different key punch operators; but it pays good dividends in terms of reducing computer stoppages caused by unacceptable data. Obviously, the possibility of different operators making identical transfer errors is remote. Mistakes still can occur, however, when errors in file card data are duplicated on the punched card. Detection of file card errors can be effected through examination of punched card tabulations or by checking the data on the file cards themselves.

Removing incorrectly punched cards from a deck is a tedious and time consuming process because it frequently must be done by hand. Trying to recognize unwanted cards from the pattern of punched holes is anything but easy, so we pass our cards through an interpreting machine. This prints a series of numbers in the upper left-hand corner of each card, and from them we can readily tell what the data on the card represent. For example, the first three printed numbers may represent the sampling station number and the following figures will list the day, month, and year in which the sample was collected. Since all of our data cards are filed by station number and also in chronological order of sample collection, these items serve as a ready means of card identification. Perhaps we should also point out that proper card identification not only facilitates removal of erroneous data, but also simplifies extraction of valid data selected for special statistical analysis. Usually, mechanical sorters are used for separating large numbers of cards; but, if only a few are involved, it is sometimes practical to sort them by hand.

Since a computer program requires cards having different functions in the data processing system, the cards should be separated and filed in groups representing the various components of the program. For example, basic data cards should be separated from instruction cards that tell the computer what to do. One of the simpler ways of doing this is by using different colored cards for the various sections of the program. Cards are produced in many different colors and shades, so a large variety of color contrasts are available for this purpose.

Permitting accumulation of a large backlog of unprocessed data is certainly one of the better ways to impair good program development. It is virtually impossible to judge the quality of a data reduction process without looking at the final product. Early and routine examination of the output from a computer program will go a long way toward timely discovery of weaknesses in the system.

Although most of our data reduction is done on electronic computers and peripheral equipment such as sorters, collators and tabulators; some of the basic computations are still performed on a desk calculator. Particulate concentrations are hand calculated from substance weights and total air volume. However, we have found a practical short-cut for determining air volume in cubic meters from the average of flowmeter readings observed at the beginning and ending of each sampling period. Airflow is measured with a rotameter which requires a calibration curve for converting observed meter readings into cubic feet per minute. Misreading the calibration curve presents a source of error in airflow calculations; so we have prepared a conversion table for each curve. From the table we can read airflow in cubic meters per minute directly from the flowmeter reading. At first glance, it might appear that preparation of such a table would be prohibitively time-consuming. Actually, such is not the case. With a desk calculator the conversion units can be tabulated in about twenty minutes. Also, some of the calibration curves are nearly identical, so a given table may be used for more than one curve without introducing significant errors. In the near future we hope to supplant virtually all hand calculations with an automated system. A computer program which calculates pollutant concentrations directly from field data and laboratory analyses was successfully used in a municipal air pollution survey at Nashville, Tennessee. In this program, the equation of the airflow calibration curve for each sampler enters into the computations. Since samplers are recalibrated from time to time, appropriate changes in computer program cards must be made for each calibration. This apparently did not present a problem in the Nashville survey because comparatively few samplers were involved. However, in a large scale network, this aspect of the program will require rather careful attention.

The advantages of automated techniques depend, of course, on the volume of data involved. In comparatively small projects it may be unfeasible to employ a program writer and to pay for computer services at standard commercial rates. To assist in the development of data handling procedures for the smaller networks, we have advised their directors to pattern their data recording systems after ours so they may use our existing computer programs, at least until they have had an opportunity to design systems better suited to their needs.

Since dissemination of Network data is one of our responsibilities, we also have applied automatic methods to this phase of our operation. In this respect, the electronic tabulator has been used in the preparation of both routine reports and special publications. The routine reports distributed to Network participants are tabulated on commercially prepared forms which indicate where and when each sample was collected. Concentrations of substances for which each sample was analyzed are listed after the appropriate dates of collection. An original and seven copies of each tabulation can be printed by a single pass of the cards through the tabulator. We have also used this method for preparing data tabulations for subsequent reproduction by offset printing and thus have eliminated typographical errors common to printing from set type. This in turn relieves at least two people from the tedious task of proof-reading a mass of tabulated material just prior to final reproduction.

Since most of our data become available for public consumption, either through our own publications or other means, we must exercise every precaution to insure accuracy of data released. This not only helps gain popular appeal for the program, but also spares the project director from answering detailed criticisms. Explaining errors can be a very time consuming and unpleasant task.

In a project such as ours, where headquarters is far removed from most of the field stations, communication barriers introduce problems in the exchange of information between field and laboratory. Therefore, rather careful planning must go into the design of forms on which field data are to be recorded. The forms must be self-explanatory to help minimize correspondence between field and headquarters. They also must be functional to permit easy and accurate transfer of data to permanent files and to facilitate rapid checking of data. Provision must be made for recording unusual conditions (dust storms, forest fires, etc.) occuring during the sampling period. Obviously the latter is necessary for proper interpretation of sampling data. The center section of a record sheet is a good place to note unusual circumstances and also to insert comments pertaining to equipment operations. By allowing ample space for this purpose, we not only provide a convenient means for sending messages from field to headquarters, but also incorporate an area that may be used for recording data items added through expansion of project activities. Most commonly used data, such as station identification or basic sampling measurements, like total air volume, should be placed near the top or bottom of the record sheet where they can be observed readily for data checking. Since most raw data are recorded in long hand, the spaces allocated should be adequate for legible recording. To improve versatility of the record form, it is also desirable to make spacings in multiples of six lines per inch vertically and ten per inch horizontally so they will agree with standard typewriter intervals.

If samples cannot be collected on a daily schedule, a suitable method must be developed for designating sampling periods on an unbiased, less frequent basis. A statistically acceptable procedure for doing this involves the selection of sampling dates and times through the use of a table of random numbers. This is the method we use for preparing sampling schedules which list the time and date of collection for obtaining one sample every two weeks. A new schedule is prepared for each station for each year of operation.

Just what is done with all of the data obtained by the Network operation? A detailed tabulation of all data from an individual station is sent to the proper local agency at the end of the first three months, also at the end of six months and finally a full report is supplied at the end of each year. A summary, in the form of frequency distributions of suspended particulate data for all stations by population class, is included with the year-end report. This permits the individual station operator to compare his station with others in the same population class. The proper state agency receives copies of all reports sent to stations in the state and each PHS Regional Office receives copies of reports for all stations in the region. Copies of all reports also are sent to the PHS Air Pollution Medical Program in Washington, and copies of all reports containing radioactivity data are given to the Radiological Health Division. No information is released to the press or to private individuals unless prior approval has been given by the local agency.

The local agencies are free to use the air quality data as they see fit. Many agencies publish their data in the local newspapers, and by so doing, keep the local citizenry informed of their continued participation and interest in air monitoring in the community.

The data are also used as a basis for numerous papers and reports. Many of these are factual in nature and contain either summaries or detailed presentation of actual data. With the accumulation of vast quantities of comparable data, it will be possible to do a variety of statistical analyses and future reports will include the results of these analyses, as well as simpler presentations of newer data. The first report on the statistical analysis of Network data was presented this year, and dealt with the use of the standard geometric deviation and geometric mean for the evaluation of the air pollution potential of a community. Other analyses are being performed on a continuing basis. It is expected that, in another year or so, sufficient data will be available to permit a preliminary investigation of possible trends in air pollution levels. When we have arrived at this point, it will represent a major advance toward the achievement of one of the major objectives of the Network.

In summary let us say that the data handling aspects of an air monitoring network should be an integral part of the project and should be given ample consideration in all stages of overall program planning.

CHAIRMAN GRUBER: Thank you, Mr. Hanson.

We have a change to make in our program. Our next speaker was to be Mr. Zimmer and it seemed like the stork caught up with Mr. Zimmer about 5:00 o'clock this morning and his wife presented him with a new baby. Dr. Ralph Larsen of Air Pollution Engineering Research staff will present Mr. Zimmer's paper on Data Analysis.

DATA ANALYSIS

C. E. Zimmer

Presented by R. I. Larsen

DR. LARSEN: Thank you, Mr. Gruber.

Mr. Zimmer, as Mr. Gruber told you, had a blessed event today and is home busy with the five other little Zimmers. Three of us in the past four months have had children at equally inopportune times, times when the program needed us direly. We have been accused by our chiefs of inadequate planning, and I think they may have something there.

Since Charlie pinch-hitted for me when I was out, I will pinch-hit for him this morning. First, I would like to say that Charlie is an excellent statistician. That is his main field by occupation. I am an engineer with some interest in statistics, so I am not nearly as immersed in the field as Charlie, but will try to answer any questions that you may have.

The subject of data analysis is fundamental to any scientific investigation and as such merits consideration in the initial planning of a project. Far too often the investigator does not appreciate the importance of planning for data analysis in advance, until he is buried under an avalanche of figures. Even then the situation may be hopeless, especially when the implications and conclusions inherent in the data are fairly obvious. Many times, however, the data are complex and a person unfamiliar with statistical methods is forced to seek help and is disconcerted to learn that the statistician does not have a magic formula which will substitute for faulty or insufficient data. In general, the problems associated with data analysis can be minimized if the project is conducted following a good statistical design.

In the field of air pollution research, as in most scientific investigations, the experimenter is seeking answers to basic questions. Generally the only way to answer such questions is to make certain measurements of air quality. The magnitudes of these air quality measurements are affected by many factors such as population density, industrial activity, topography, meteorological parameters, etc., each of which may act in a way as to cause variation in the response variable being measured. In an air sampling program it is important that the design be such that an estimate can be made as to the effect of each known source of variation. Care should also be taken to minimize the effect of random sources of variation. In addition the economics of the sampling program must be investigated in order to provide a maximum of information with a minimum expenditure of time and money.

I do not mean to imply that an investigator absolutely should not conduct an experiment without first seeking competent statistical guidance, but it must be admitted that, if an experiment is worth doing at all, certainly it merits good statistical planning.

The National Air Sampling Network was designed to show the nature and extent of air pollution in the United States and to show possible trends in the concentrations of specific pollutants for individual areas. In order to meet these objectives and to provide the widest possible coverage it was decided to select a representative site in each city or non-urban area, with samples collected once each two week period. We realize only too well that there are inherent limitations placed on the value of such data, especially when comparing data for different sites. Obviously the selection of the sampling site for an area is very critical and deserves serious consideration. Data collected in this manner can never substitute for intensive community air pollution studies but we hope that information made available through the network will provide an impetus for such detailed studies.

The basic ideas of an air monitoring and sampling network are not restricted to a large scale operation like the National Air Sampling Network. Indeed this idea can be applied to a state or even a community study of air pollution. Many of these studies have been conducted in recent years. We of Air Pollution Engineering Research have been involved in two intensive community studies, namely Louisville, Kentucky and Nashville, Tennessee, each of which was designed for a specific purpose.

The Louisville Community Air Pollution Study was designed for the purpose of studying the effect of air pollution from a known source. The aerometric network was planned specifically for this purpose, with several stations located in the west end of the city just north of the source, another station located south of the source and a control station was set up east of the source. Operations of the network were carried out continuously for over a year. The results of the analysis of the air quality data substantiated the original hypothesis concerning the cause of the air pollution problem in the west end of the city.

In Nashville the basic objectives were to study the effects of air pollution upon the health of the individuals within the community. In addition this project offered an excellent opportunity to do some needed research in sampling methods and techniques. The design of the aerometric network was to saturate the community with sampling stations and at many stations several sampling methods were used to measure certain pollutants. This study will serve not only to answer questions concerning the health effects of air pollution but also provide answers as to the optimum number and location of sampling stations as well as enabling a determination as to the most efficient sampling methods.

The basic data analysis necessary to meet the objectives of the National and other similar networks involves the computation of certain sampling statistics, as for example, means, standard deviations, extreme values and frequency distributions. These statistics can be computed using methods described in any elementary statistical text. Such computations are admittedly quite simple to perform when one is concerned with data for only a few sampling sites. The computations become quite laborious and tedious when computing the statistics for several hundred sets of data. A task of this nature can be performed more efficiently and economically using high speed electronic data processing machines as, for example, the IBM 650.

Electronic data processing machines are ideally suited for performing highly repetitive computations. The machine does not tire after a while and one can feel certain that the last answer is just as accurate as the first. Of course, these computers are also quite useful when performing extremely difficult mathematical manipulations of the type involved in multivariate analysis. Basically, the computer is capable of performing additions and subtractions and making logical decisions and does these operations at the rate of thousands a second. A computer like the 650 will read data from punch cards at the rate of 200 cards per minute and punch at 100 cards per minute and still perform considerable interval computations without slowing up this input and output speed.

The 650 uses an internally stored program to perform operations and therefore it is necessary to write a program for each task the computer is asked to do. Special training in program writing is required in order to learn how to communicate with the computer. Recent developments in program compiling methods have made it possible to train an individual to write moderately complex programs with only a few hours of instruction. In fact, some of these new methods use a language not unlike ordinary algebraic statements.

We have been using the IBM 650 in the analysis of network data for almost two years and, as a result, have developed several programs. The basic program now in use, referred to as NASN#1, will compute such things as numbers of samples, means, extreme values and cumulative frequency distributions in the form of deciles. These statistics are computed on the following basis: annually for each site and all years for each site; annually for each city and all years for each city; all years for each state, Public Health Service region, and nationally. In addition, monthly data in the form of number of samples, minimum, maximum and mean concentration over all years is computed for each city. The program requires a separate pass of the punch cards for each pollutant, such a run requires about 5 hours for the 14,000 samples collected between 1953 and 1958. A summary of the 1953 to 1957 in this manner (1) was distributed to all National Air Sampling Network participants and is presently available only through the Government Printing Office.

While developing the basic program there was an apparent need for some special routines which could be used in conjunction with the NASN #1 program. One of these programs provides for a rapid scan of the data in advance of a run using the NASN #1 program. The sole purpose of this initial run program is to look for such things as blanks or double punches on the card and to find the range of values for a specific pollutant. This program runs at the rate of 200 cards a minute and requires about one hour of machine time for all of the 1953-1958 data. Another program generates the necessary frequency distribution tables which must be read into the computer in order to use the NASN #1 program. Still another program converts the numerical city code on the output card from the NASN #1 program to an alphabetical name.

A second major program, NASN #2, which was developed only recently and is now ready for use, provides more detailed data on a state, regional and national basis. This program will compute the number of samples, means, extreme values and cumulative frequency distributions in the form of deciles, for each year up to a total of five years on a state, regional and national basis. In addition, monthly data in the form of number of samples, minimum, maximum and mean concentrations are computed over all years for the state, regional and national totals.

These programs have been written up in detail in the form of a manual (2) which is available upon request. In addition, we are in a position to supply duplicate decks of program cards to organizations interested in analyzing data in the manner described.

Preliminary studies have indicated that concentrations of particulate pollutants are in general log-normally distributed. This characteristic can be demonstrated quite eaily by plotting the deciles of the cumulative frequency distribution on log-probability graph paper. Such plots are approximately linear. In order to test the hypothesis that such distributions are in fact normal, several hundred distributions of suspended particulate concentrations for cities all over the country were tested for departure from log-normality. The number of distributions with significant departure was quite small and indeed failed to disprove the hypothesis of log-normality. Admittedly, the true distribution may in fact be more complex in nature than we have indicated.

Assuming that concentrations of particulate pollutants are log-normally distributed, it is appropriate to use geometric means and standard geometric deviations in studying pollution levels. Again, these parameters can be computed using standard methods after transforming the original measurements to logarithms. It has been shown in (3) also, that an estimate of these parameters which is well within the limits of accuracy of the original measurements, can be obtained from the deciles of the cumulative frequency distribution. Here, as before, in view of the quantity of data involved, it is more efficient in our case, to obtain these parameters using the 650 computer. A program was written which takes the output from the NASN Nos. 1 and 2 programs, performs the necessary arithmetic operations and punches out cards at the rate of one every 10 to 12 seconds.

A plot of the cumulative frequency distribution on log-probability paper provides a useful tool in the study of air pollution. It is possible to make comparison between two distributions by studying the relative position of each line. Further, one can make approximations of concentrations expected to occur with some definite frequency.

The geometric means and standard geometric deviations can be used to meet the first objective of the NASN concerning the extent of air pollution in the United States. A comparison of the magnitudes of the geometric means of many cities will pinpoint those areas with unusually high pollution levels. In addition, by considering both the geometric means and the standard geometric deviation it is possible to pick out those areas with a potential of extremely high concentrations for brief intervals of time. Consequently, these two parameters, when used simultaneously, should enable the selection of areas in which intensive community air pollution studies are most needed.

In the analyses of air quality data there are apparent differences in the levels of concentrations of a specific pollutant, for a given community, from one year to the next. Such differences can be real or merely reflect chance variation associated with sampling. These differences can be tested for significance using the student "t" test which employs the geometric means and standard geometric deviations. Then, if the difference is judged to be significant and not a product of chance variation, it becomes necessary to look for possible causes of this difference. The difference may have been brought about by a real change in source strength or by variations in some of the variables affecting the measurement, as for example, a difference in some meteorological parameter.

The ability to detect trends in the level of concentration for a particular pollutant is dependent upon several years of data. Unfortunately, the network has not been in operation sufficiently long to spot such trends for most cities. In the future though, after we have amassed several years of data we will begin investigating annual differences for possible trends. Analysis of such trends should indicate the development of potentially serious air pollution problems and appropriate measures can be taken before the situation actually becomes critical.

The various data analyses described thus far are more in the nature of summaries. At the present time we are in the process of studying the relationships between the various pollutants which have been and are being measured. In view of the volume of data available we are developing computer programs to perform the necessary computations. We feel certain that there are indeed strong relationships between some of the pollutants and hopefully such relationships can be used as a means of eliminating some of the laboratory work which is now being done. The results of this project will be reported as they become available.

Another even more interesting statistical analysis which is still in the development stage centers around the relationship between measurements of air pollution and various socio-economic indexes.

Many of these indexes have been computed for cities on the NASN by the Air Pollution Medical Program, who used these indexes in studying the relationship between air pollution and specific causes of death. We hope to use some of these indexes plus additional ones being developed and relate them to measurements of air pollution. Through multivariate analysis it is entirely possible that one may in fact be able to preduct the air pollution potential quite accurately with a few well chosen indexes.

In addition to collecting air quality data for a large number of cities, we have also obtained, through the United States Weather Bureau, the meteorological data for the same cities on those days when air samples were taken. This data should provide an excellent means for the study of possible relationships between air pollution concentrations and such things as air stability, wind direction, etc. The statistical analysis will be of the multiple regression type which involves considerable mathematical manipulation and again the IBM 650 computer will be used to perform the necessary computations. The result of this study, we hope, will be an equation, for each city, such that by merely plugging in the value of certain meteorological parameters, a reliable estimate can be made as to the concentration of a specific pollutant. Naturally, this estimate will assume that there has been no significant changes in source strength.

I have mentioned but a few of the possible statistical analyses of the air quality data. There undoubtedly are many, even more interesting, investigations that we have not as yet considered. As we broaden our knowledge, of the air pollution problem, we should make ever increasing use of the valuable source of data made available through the Network operations.

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CHAIRMAN GRUBER: Mr. Hanson and Dr. Larsen, thank you very much. Does someone wish to lead off with a question?

MR. SMITH: How many items of data do you think are needed before it is warranted to go into a card punch routine?

DR. LARSEN: This is typically the first question that arises. I think it depends on at least two things.

First, it depends on your bent or interest in using this new technique and whether resources are available or not. For instance, a state may have university resources at a very reasonable price. If you have to pay for commercial services, a larger endeavor may be required before it becomes profitable.

It depends a lot on the study and whether you are already using computers or not. If you are not doing anything in programming, I would suspect it would take on the order of 1,000 or so sets of data before one would choose to begin using a computer. With less data you could still use a tabulator.

If you are already in the computer business and have the facilities readily available, I would say if you have only 100 or so sets of data, you would use a computer. As you use computers from day to day, they become like a slide rule to you. You just pick it up, get your answer, and use the results.

They are not an "Open Sesame" in themselves. You have to be careful using them as you have to be careful the way you slide your slide rule. Does that answer the question?

MR. SMITH: In part. I'm sure that many people will not take enough data to warrant even thinking about computers and I hope that you are not frightening them away from tabulating data on cards by the thought of computers, because, as you well know, there is the old darning needle system as well as a number of other systems for sorting data.

DR. LARSEN: That's right. The key sort system is good for stratifying data, especially if you have a few hundred cards. In another operation we used to use this method. The IBM card punch method is very good for keeping your data and running it through a tabulator almost without respect to the number of pieces of data you have. It is just a good way to keep your results very orderly. I'm glad you brought up the McBee system. Thank you.

CHAIRMAN GRUBER: Any other questions or comments?

MR. SCHAFER: The discussion covering the various aspects of data processing has been most interesting, especially in view of the fact that we have a considerable amount of unprocessed data that has been collected in Columbus over the past ten years. I would welcome some suggestions for an approach we might follow for analyzing the data without purchasing electronic computing equipment or employing full time personnel specifically trained for developing computer programs.

MR. HANSON: I would suggest that someone from our data processing unit examine a sample of the Columbus data to see whether the information could be transferred quite readily to punched cards and then processed with one or more of our computer programs.

CHAIRMAN GRUBER: I would like to emphasize this question of giving thought to how you record your data. Even though you don't have any thought of putting it on IBM cards now, sometime in the future this may be desirable. Our Air Monitoring data sheets are set up so that should we want the data on cards, all we have to do is hand our notebook sheets to a key punch operator. The data is coded and arranged in columns.

MR. STERN: When people read about the tremendous cost of computers and their peripheral equipment, they are scared by the amounts. They read in the papers of a computer costing a half a million dollars and the other equipment costing so much, and they feel this isn't for me; I'm not in that league. Actually there are many, many sources for renting time on equipment of this nature at fairly reasonable per hour costs. Every step of the process can be handled in this manner.

Transcribing data to punch cards can be done for a per hour charge. Most Public Health Departments have in their vital statistics or payroll departments, the basic punch card facilities and have it accessible to them, if not on regular time, perhaps on an overtime basis.

Library programs for doing many of the mathematical operations are available by merely going to one of the service groups, stating your problem and having them look in their library of programs to find one either already tailored to do the particular analysis you have in mind or which can be readily adapted. Programs for special purposes, such as those we have developed, are available and can be handed to a computer operator as a deck ready to use.

If somebody wants to use one of our programs, all you have to do is to get from us a deck of cards which instruct the computer what to do and give it to a computer service agency in your area that will rent time to you, along with an instruction manual of the type we have available to explain the operation of our computer programs. You, yourself, do not even have to know how the program operates. You merely have to know the result you are seeking or be satisfied with the result this type of program will give. For a moderate amount of data, 15 minutes or half an hour of machine time, costing anywhere from $20 to $50 may give you some of the answers you are seeking.

MR. GARLAND: In many large Health Departments, State or County, data handling equipment is available. For instance, in Atlanta we have a lot of automatic equipment and a lot of tabulating equipment and so forth in the vital statistics department which is used for every purpose. We have been indulging in an active program on rabies vaccination on dogs. You wouldn't think that would be applicable, but in one of these sessions on a Saturday afternoon, for example, you would get 500 dogs vaccinated and each one with the name of the owner, the name of the dog, the date, the time, the immunization and so forth on a little card that you fill out manually at the place and, in a week's time, you will end up with several thousands of these things. Why couldn't these resources be used for handling this type of data as well as anything else. Would that be an approach to getting some of this recorded, such as Mr. Schafer is wondering about?

DR. LARSEN: I think that's an excellent approach and probably one that each state could explore very profitably. You will find your state offices of vital statistics do have the punching equipment, the sorting equipment, the tabulators, and many of them are now leasing computers. I don't know how your state charges departments, but I would expect that you would be able to get these services for a very nominal fee. I would recommend this as a first step to any state agency, to investigate the resources of your vital statistics department.

MR. FRENCH: Is there a standard method of data keeping such as you have now that we could be doing so we could all get into the card business at the proper time, so we could be doing this properly at the moment and won't miss out when the time does come?

CHAIRMAN GRUBER: The way we keep our data was published in one of our early papers. Any other comment?

MR. SMITH: Charlie, why didn't you use mark sense cards right from the beginning instead of putting it down in table form?

CHAIRMAN GRUBER: We know of that and we decided against it. We had no immediate punch card program, so that the written data in tabular form is easier for us at present. Perhaps Dr. Larsen has a comment on the use of mark sense cards.

DR. LARSEN: First I would like to ask those of you in the audience what experience you have had on mark sense cards. Mr. Smith, have you used it in your work?

MR. SMITH: We use them extensively but not in this particular program.

DR. LARSEN: What have you found to be the advantages and disadvantages for your particular application?

MR. SMITH: Well, our problem right now is about computer time. We tried to get time within the department, actually within our Division of Vital Statistics. They are completely bottlenecked, in machine time for tabulating purposes and in the key punch operators. We use mark sense cards originally to get around the key punch bottleneck in our study of the time distribution of field personnel. These people take the cards into the field, mark them themselves at the time of the stop. This eliminates the key punch time completely. We feel that the marking of the cards is reasonably accurate considering the type of people who are doing this and the purpose it is being done for.

In another program -- which is perhaps more similar -- these cards are used for the tabulation of fluoride analysis. The chemists mark the card at the time of the analysis. We found in general this was as accurate as his writing down the end result of his analysis on a piece of paper and shipping it off to somebody else to punch a card.

DR. LARSEN: Thank you for an observation on mark sensing.

Twenty-seven marks may be palced on each side of a card, or a total of 54 digits as opposed to 80 digits of direct punching. It is marked with a pencil and fed into a machine which senses the marks and punches corresponding holes in the same card.

We have considered this system for network operations. One problem is that only 54 columns of data may be recorded on a card by mark sensing. Another problem is to obtain uniformity among those who are marking the cards.

I think it is a potentially good system, especially if only a few numbers are to be marked such as when a lab chemist weighs a sample. If lots of marks are to be made and the participants are not too well trained in mark sensing, I would tend to favor the written piece of paper which would then be punched by a key punch operator.

I would like to reply a little bit to Mr. French's earlier question. If you are considering a system, here are several things you might do first. Make certain you know where your sample is collected, when it is collected, and what it represents. You may wish to designate your sampling stations by number from 1 to 100 and locate that in the first two columns. You may want to put the date in the next six columns, the month, the day, and the year. You may want to use a number for the type of pollutant; Los Angeles does this -- e.g., 12 is CO and 15 is oxidant. So if you identify what you collected, when you collected, and where you collected, you have the essential information. This information can be placed in any columns of the 80-column card. Just be sure its always placed in the same columns.

MR. KOCH: This reminds me, have these wonderful machines been able to subtract dates to get elapsed time?

DR. LARSEN: I'm glad you asked that question for I wrote a program to do just this. We will be glad to give you that program.

CHAIRMAN GRUBER: Mr. Maneri.

MR. MANERI: I have a code sheet that we developed and I was just wondering if we could project it on the screen so the people here could get an idea of what was involved.

VOICE FROM THE FLOOR: May I suggest this might be put in with the proceedings and we will all have it?

CHAIRMAN GRUBER: Yes. This will be done.

MR. SMITH: Would it be possible to use the same treatment on the services data system?

MR. MANERI: I might add that this was developed to be consistent with the way the National Air Sampling Network data are recorded.

MR. SMITH: Essentially they are the same?

MR. MANERI: Essentially they are the same with some small differences.

DR. LARSEN: May I just see that a minute? Essentially this is a very neat listing of the 80 columns on a punch card with provisions for station number, date, site, and concentrations of particulate, radioactivity, and the several metals. It is a very orderly arrangement and would be very good for a key punch operator to use. Each little block represents a column on an 80-column card.

MR. DOUGHTY: How do you verify the reliability of a key punch operator?

DR. LARSEN: You used the right word. You use a verifier. As Mr. Hanson mentioned, you essentially punch the cards twice. The operator first punches the data the way it looks to her. The cards are then placed in a verifier, and a second girl sits at the console and operates a keyboard to check each hole. If she disagrees with the first girl, a little red light lights up and she then determines if she made the mistake or the first girl made the mistake. If the first girl made the mistake, a button is pushed and a little hole is punched in the top of the card. It is then fed back for repunching. An important phase of the system is to have validity checking, as Mr. Hanson mentioned, to make sure you don't put bad data in the system to begin with.

MR. STOCKMAN: Thinking of Mr. Maneri's data sheet there, I have had the impression over the years you would like to have data coming in here from our own local networks. We have sent some in from time to time, in the form of monthly summaries.

NEW YORK STATE DEPARTMENT OF HEALTH

State Air Sampling Network Data

Coding Instructions for Record Sheet

The following data should be entered on the record sheet in red ink.

Card. Col.	Item	Code
1	Card Number	Circle the number of the card in the boxes under column 1. 1 = Card 1 2 = Card 2 3 = Card 3
2-7	Automatic skip	------------------------------
8-9	Laboratory Designation (to be handled in Albany)	To be gang-punched into IBM cards in Albany office. 01 = Syracuse 02 = Div. of L & R, Albany 03 = Niagara Falls City
10	Number of days covered by sample	0 = N. F. (no filter) 1 = 1 day 2 = 2 days 3 = 3 days 4 = 4 days

----

The following four items refer to the actual date of the sample which is understood to be the date on which the filter is placed on the sampler.

11-12	Month of sample	01 = January 02 = February 03 = March 04 = April 05 = May 06 = June 07 = July 08 = August 09 = September 10 = October 11 = November 12 = December
13-14	Day of month of sample	Use the exact calendar day of the month. Example: 02 = 2nd day of month 30 = 30th day of month

Card Col.	Item	Code
15	Day of week of sample	1 = Sunday 2 = Monday 3 = Tuesday 4 = Wednesday 5 = Thursday 6 = Friday 7 = Saturday
16-17	Year of sample	Use last two digits of the calendar year. Example: 58 = 1958 59 = 1959
18-21	N.Y.S. Station Identification	A four-digit geographic location code to be filled in by the Central Office in Albany.
22	Site	A one-unit alphabetic code to be assigned by the Central Office in Albany.
23-26	Suspended particulates	Number of micrograms of suspended particulate matter per cubic meter of air. This measurement should be rounded off to the nearest whole number. If fractional measurement is less than .5, drop the fraction if greater than .5, raise to next whole number. In cases where a measurement cannot be determined because of torn filters, breakage of equipment, etc., code: R = Unascertained in col. 23 and dash out cols. 24-26
27-30	Organic (Benzene soluble)	Number of micrograms of organic matter per cubic meter of air rounded off to one decimal place. Use same method for rounding as for particulates. In cases where a measurement cannot be determined, code: R = Unascertained in col. 27 and dash out cols. 28-30

Card Col.	Item	Code
31	Beta Radioactivity Counts	0 = Extrapolated back to collection day. 1 = Actual radioactivity count on the 11th ± 1 day after collection. 2 = Actual radioactivity count on the 20th ± 1 day after collection. X = Absurd result. R = Unascertained or not determined.
32-35	Beta Radioactivity	Number of micro microcuries of beta radioactivity per cubic meter of air rounded off to one decimal place. (Use same method for rounding as for particulates.) If an "X" or "R" appears in col. 31, dash out cols. 32-35.
36-39	Blank	--------------------------------
40-42	Beryllium	Leave blank.
43-46	Sulfate	Round measurement to one decimal place. If unascertained or not determined code as follows: R in col. 43 cols. 44-46 dash out
47-50	Nitrate	Round measurement to one decimal place. If unascertained or not determined code as follows: R in col. 47 cols. 48-50 dash out
51-53	pH	Round measurement to one decimal place. If unascertained or not determined code as follows: R in col. 51 cols. 52-53 dash out
54-56	Blank	--------------------------------
57-59	Fluoride	Leave blank
60-80	Blank	--------------------------------

Note: In each case where the sample data will be reported at a later date, a separate record sheet should be filled out showing the station, date of the sample, and the following footnote:

Data will be reported at a later date.

WLB/pb
5/20/59

NEW YORK STATE DEPARTMENT OF HEALTH

RECORD SHEET FOR NEW YORK STATE AIR SAMPLING NETWORK DATA

Station__________________________________ **Date**________________

Item	Cd. No.	NASN Station Ident. Code									Month		Day		WD WE	Year		NYS Station				Site	Particulate µg/CuM			
Card Col. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	1	Program Automatic Skip																								
	2																									
	3																									

CARD 1

Organic µg/CuM	27 28 29 30
B Radioactivity µµc/CuM	31 32 33 34 35
	36 37 38 39
Be	40 41 42
Sulfate	43 44 45 46
Nitrate	47 48 49 50
pH	51 52 53
	54 55 56
Fluoride	57 58 59
	60 61 62
	63 64 65
	66 67 68
	69 70 71
	72 73 74
	75 76 77
	78 79 80

CARD 2

B Radioactivity µµc/CuM	27 28 29 30 31
Mn	32 33 34
Pb	35 36 37
Sn	38 39 40
Fe	41 42 43
Cu	44 45 46 47
Ti	48 49 50
V	51 52 53 54
Zn	55 56 57 58
Cr	59 60 61
Ni	62 63 64 65
Mo	66 67 68
Co	69 70 71
Bi	72 73 74
Cd	75 76 77
Sb	78 79 80

CARD 3

Organic µg/CuM	27 28 29 30
Starting Time: Month, Day, Hour	31 32 33 34 35 36
Hour Off	37 38
	39 40 41 42 43 44 45
	46 47 48 49 50 51 52
	53 54 55 56 57 58 59
	60 61 62 63 64 65 66
	67 68 69 70 71 72 73
	74 75 76 77 78 79 80

You must be getting it in perhaps quite a variety of forms. Is this something you are actually using or can use or is it taking up file space? I mean do you really want it unless we all go on a uniform system?

MR. HANSON: The amount of data we have received thus far from outside sources has been so limited that it has been impractical to employ automated processing techniques for evaluating the information. When data are sent to us, it would be preferable to submit them on forms similar to those used in our Network. We are still interested in collecting and processing data from outside sources and shall do everything we can to return meaningful information to the contributors.

CHAIRMAN GRUBER: Gentlemen, the discussion period is over. I want to close this session by thanking all four speakers for their excellent papers. The discussion was certainly lively and considerable exchange of information took place this morning.

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AFTERNOON SESSION

The Afternoon Session convened at 1:30 o' clock p.m., with Mr. Arthur C. Stern, Chairman, presiding.

- - - -

CHAIRMAN STERN: Gentlemen, I am pinch-hitting for Vernon MacKenzie who is unable to be present with us, and who was originally scheduled to be Chairman of this session.

Before introducing the first participant in the session, I would just like to make one comment concerning the tabular material that is on the table in the anteroom here. There is a table running through several pages listing results from 1957 and 1958 of the National Air Sampling Network for total particulate. The reason for placing this material on the table is as follows: The current issue of the Journal of the Air Pollution Control Association, which was shown you initially yesterday by Arnold Arch, contains the article in which that table originally appeared. However, due to an unfortunate error at the printers, only the first quarter of the table was reproduced in this issue. The material on the table is the complete material which will appear in the next issue of the Journal to bring the article to completion, however, for those who want complete data now, it is available on the table.

The first participant this afternoon in discussing the subject of the use of network and monitoring and sampling data is Mr. Charles E. Couchman, the Director of the Bureau of Industrial Hygiene of the Baltimore City Department of Health.

USE OF DATA

Charles E. Couchman

MR. COUCHMAN: Before data can be interpreted to serve a useful purpose a marked degree of confidence must exist in that it was assembled reliably, using, if possible, known and proven methods. As an analogy the title of this paper may be likened to the use of money. Basically, the money which is used for exchange for services and goods must have an intrinsic value beyond any reasonable doubt. Certainly it cannot be counterfeit or it is useless. Hard money might be likened to factual information and cheap money to questionable data. Because work is necessary to obtain either good money or reliable data -- and it generally involves hard work -- both should be used judiciously in order to obtain a maximum yield for the efforts expended.

Further, the money of one country, except for purposes of exchange, is usually not of much value in another land. This is invariably true also of data which may have been gathered for one problem and an attempt is made to use it for an entirely different purpose. This point is made by Dr. William G. Cochran, a Professor of Statistics (1), in an unusual manner as he relates, "I owe my first post, in the depression, mainly to the fact that my employers had a large batch of past data which were regarded as a potential mine of information. They hired me to dig it out. I dug furiously, but I doubt whether they received their money's worth. Fortunately, my salary was so low that this moral problem caused me no loss of sleep."

Since the use of data is thought to be a prime function of a statistician and since Dr. Cochran is an authority in this field, considerable confidence should be placed in that part of his paper dealing with the historical development of the Royal Statistical Society in London slightly more than a century ago. "--- the motto of the new society --- consisted of a fat sheaf of wheat, representing the abundant harvest of data that had been collected and tidily arranged. Around the motto was an ornamental ribbon, like the ribbon worn by Miss Atlantic City in the beauty contests. But in place of the words 'Miss Atlantic City' was the Latin motto 'Aliis exterendum' - 'Let others thrash it out.'"

Professor Cochran's research techniques in the use of data as they apply to the study of human beings are quite rational and realistic. In many respects the logic parallels that of methods used in physical sciences and so interestingly described by Dr. Edgar B. Wilson, a Professor of Chemistry, in his book (2) entitled "An Introduction to Scientific Research." Any seeming difference between the two viewpoints is mainly one of wordage rather than basic meaning. Anyone interested in the subject of obtaining and using data should find the literature referred to stimulating.

Data, at times, may be of a very broad nature and consists of information which is reduced to numbers in an effort to quantitate an unknown. Often the measurements are used in a relative manner to denote orders of magnitudes rather than to signify absolute or definitive values. Furthermore, data may be gathered either for subjective reasons, such as the work entailed in pure research, or there may be an objective approach so frequently employed in applied research and engineering. Occasionally the former merges or finds use in the latter. Practical examples of the use for the various types of data in the field of air pollution are given in the remainder of this paper.

Subjective Data

One form of data which may be used subjectively is complaints.

For a number of years residents near street asphalt paving plants (3, 4) complained about dust. In 1949, an intensive study was made of all seven plants in a community and some interesting findings developed from the survey. These are listed as follows:

1. The two plants causing the greatest number of complaints were orginally surrounded by vacant land which was subsequently developed into a densely populated neighborhood.

2. Due to a rapidly expanded road-building program following World War II most of the plants operated in excess of their designed capacities; hence, dust loading increased to the fourth power as the production doubled.

3. The majority of the plants were relying upon cyclone dust collectors without realizing that this type of collector was incapable of retaining fine dust.

4. Crushed aggregate from one quarry created considerably more dust than that from another source when it was dried in a rotary kiln.

After these and other factors were evaluated, conferences were held with the plant owners and resulted in the installation of effective but costly dust collecting equipment, use of the less dusty aggregate in the two plants surrounded by homes and a production schedule in keeping within plant capacity. The degree of dust suppression was evaluated on the basis of complaints received before and after control measures were installed. The production rate as well as other variable factors was essentially constant before and after the improvements. For wet collectors installed in three plants the total yearly complaints decreased from 14 to one. Three of the other plants installed high velocity centrifugal collectors resulting in an annual reduction from 117 to 11 complaints. The remaining plant used a combination of cloth filter and settling chamber with a reduction of complaints from two to one. In reality the people with their five senses were used as indicators instead of instruments, none of which has been specially designed for that express purpose even now. Of course, the use of humans without instruments for detection purposes is not always desirable because the response of the former may be quite variable depending upon the wide spectrum of psychological reactions.

Complaint data when spotted on a map may also be useful in locating an air pollution source. On occasions a foul-smelling odor may descend on a particular section of a city and affect a large segment of the population (Figure 1).

Such pollution is more apt to occur during the early evening hours when meteorological conditions are changing. Because of the widespread disturbance, confusion and gross contamination, the location of the source and cause of the emission may, at first glance, appear to be baffling. A typical episode of this type occurred in a community one evening. The next day, by carefully correlating the weather conditions with the 530 complaints made between 8:00 P.M. and 11:00 P.M. on the previous evening, the data, when placed on a map over a distance of eight miles, clearly showed a dispersion with distance and time of complaints resulting in a configuration of a 30^{o} angle, the apex of which nearly coincided with the location of an oil refinery. Workmen had failed to notice that a 300-foot flare was not burning the previous night so as to ignite over 600,000 cubic feet of gas containing hydrogen sulfide and mercaptans.

It is only fitting to acknowledge the cooperation of the local utility company in making possible a solution to this problem. They were the recipients of the 530 complaints. because the public associated the odor with leaking gas. Further, it was necessary for the

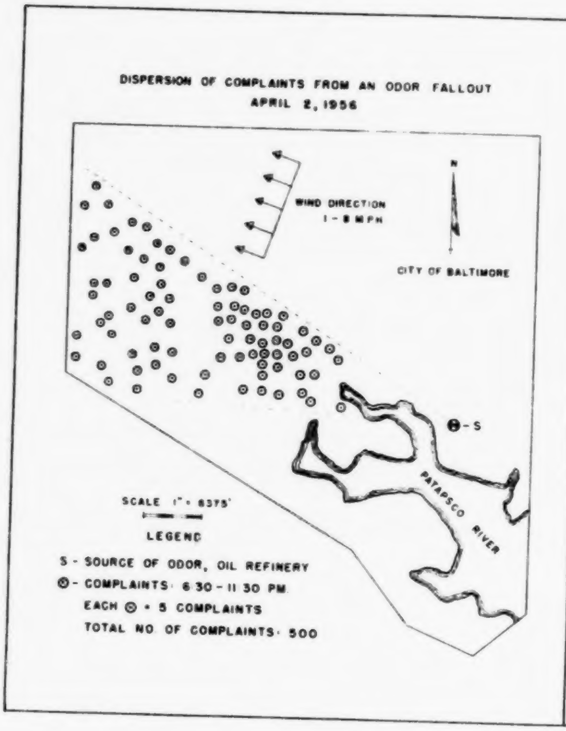
DISPERSION OF COMPLAINTS FROM AN ODOR FALLOUT
APRIL 2, 1956
WIND DIRECTION
1 - 8 M P H
N
CITY OF BALTIMORE
S
PATAPSCO RIVER
SCALE 1" = 6375'
LEGEND
S - SOURCE OF ODOR, OIL REFINERY
⊗ - COMPLAINTS 6:30 - 11:30 PM
EACH ⊗ = 5 COMPLAINTS
TOTAL NO. OF COMPLAINTS: 500

Figure 1.

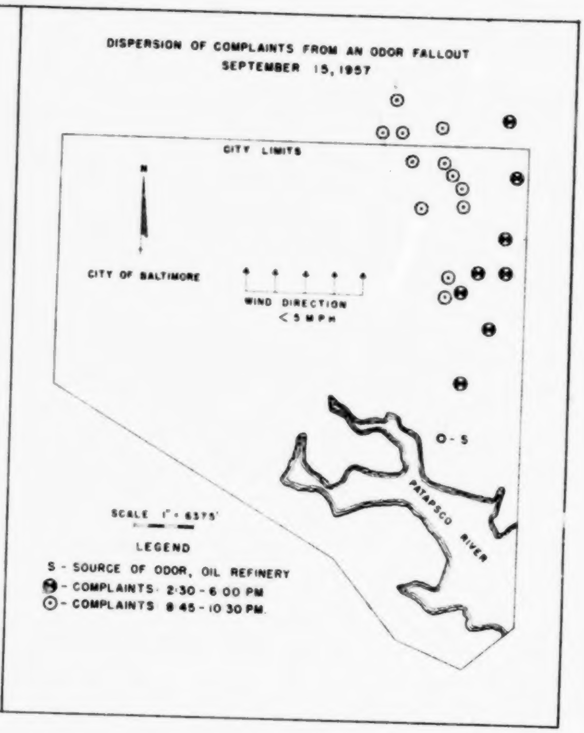
DISPERSION OF COMPLAINTS FROM AN ODOR FALLOUT
SEPTEMBER 15, 1957
CITY LIMITS
N
CITY OF BALTIMORE
WIND DIRECTION
< 5 M P H
S
PATAPSCO RIVER
SCALE 1" = 6375'
LEGEND
S - SOURCE OF ODOR, OIL REFINERY
⊖ - COMPLAINTS 2:30 - 6:00 PM
⊙ - COMPLAINTS 8:45 - 10:30 PM

Figure 2.

gas repairmen to answer the customers' calls for fear that one may have actually involved a gas leak. As a result of this episode and a few earlier minor ones, arrangements were made between the oil refinery, the utility company and the health agency that as soon as more than the normal load of six to eight trouble calls per hour are received by the gas company the other two organizations would be notified promptly. In this manner the public could be properly informed to allay possible fears from developing and the refinery could take immediate steps to correct such accidents.

Another similar episode of a smaller magnitude occurred nearly 18 months later but resulted in only 20 complaints (Figure 2).

This time a floating lid on a large sour crude oil storage tank sank below the surface and permitted hydrogen sulfide to escape. In addition to the complaints received the plant foreman notified such city agencies as the Police, Fire and Health Departments. Somehow the information was picked up by the radio and the press before an accurate evaluation could be made of the situation. On the basis of initial limited data, public warnings of rather an alarming nature were released exaggerating the degree of air contamination and even mentioning the need for evacuation. Factual data was obtained by a Titrilog (5) record. For a recording of 44 continuous hours there were only two slight detections for periods of less than 10 minutes at a sampling location closer to the tank than the residential area. The condition was corrected by pumping the sour crude oil into another storage tank.

Complaint data on dust dispersion is as applicable to map plotting as those on gas dispersion. Fallout of a black powder over a large area of the city occurred when 70 tons of material were released in a 30 minute period from an elevation of 300 feet in order to avoid an explosion. The most concentrated dust fallout area was at a point nearly 1.5 miles from the point of emission (Figure 3).

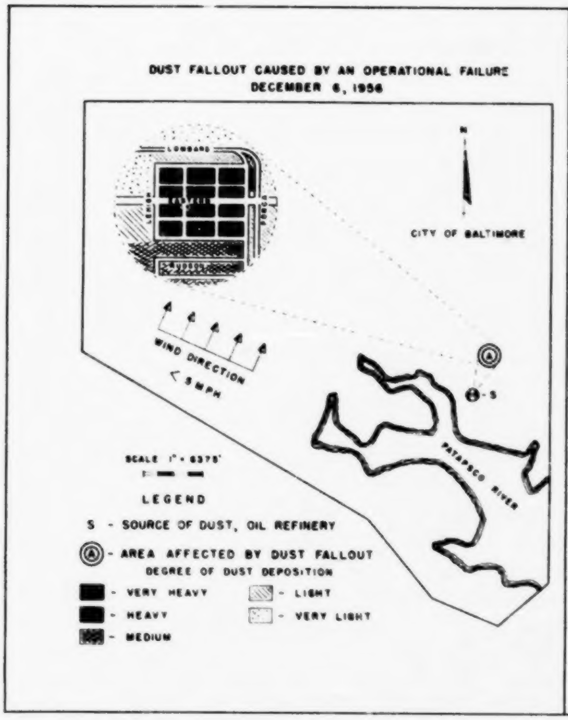
DUST FALLOUT CAUSED BY AN OPERATIONAL FAILURE
DECEMBER 6, 1956
LOMBARD
N
CITY OF BALTIMORE
WIND DIRECTION
< 5 MPH
S
PATAPSCO RIVER
SCALE 1" = 6375'
LEGEND
S - SOURCE OF DUST, OIL REFINERY
Ⓐ - AREA AFFECTED BY DUST FALLOUT
DEGREE OF DUST DEPOSITION
■ - VERY HEAVY
■ - HEAVY
▨ - MEDIUM
▨ - LIGHT
▨ - VERY LIGHT

Figure 3.

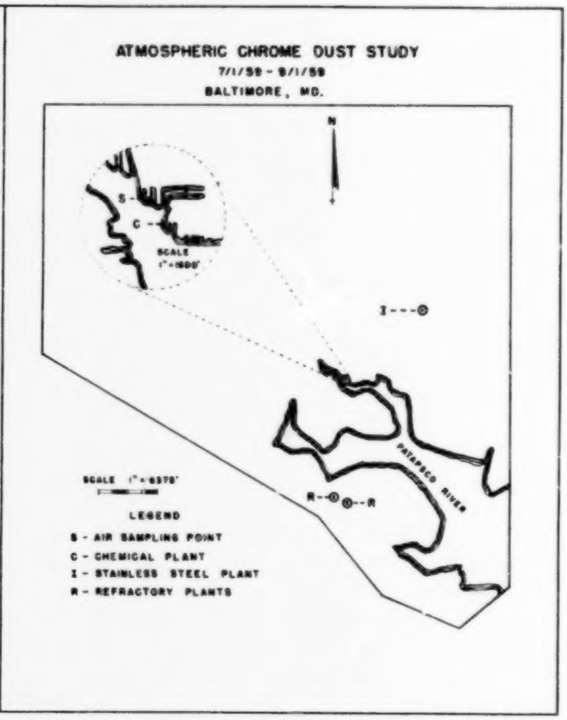
ATMOSPHERIC CHROME DUST STUDY
7/1/59 - 9/1/59
BALTIMORE, MD.
N
S
C
SCALE 1" = 1900'
I
R
R
PATAPSCO RIVER
SCALE 1" = 6375'
LEGEND
S - AIR SAMPLING POINT
C - CHEMICAL PLANT
I - STAINLESS STEEL PLANT
R - REFRACTORY PLANTS

Figure 4.

OBJECTIVE DATA

The largest published collection of comparative data of a subjective nature on air pollution appears in the book (6) "Air Pollution Measurements of the National Air Sampling Network." Thousands of analyses were made of air samples collected from 110 urban and 51 nonurban stations throughout all 50 states, the District of Columbia and the Territory of Puerto Rico. The air sample analytical data represents the period from 1953 through 1957. Of the comparative results for Baltimore City the more interesting data appeared in Table 12, Chromium. During 1957, 18 samples were collected in the city while a total of 1,381 had been collected over the more extended period of 1954 through 1957 for the entire network. The average concentration for Baltimore was ten times the national value and in addition the maximum concentration for the entire network resulted from a Baltimore sample. From an environmental viewpoint such data is significant because of the association of chromium compounds with cancer (7). Consequently, an objective study was undertaken as a result of this subjective data.

Several probable sources of emission of chromium compounds were known (Figure 4).

Chrome ore was used in its natural state in large quantities in two plants in the south-central portion of the city for manufacturing refractory brick and its chemical composition is unaltered in the final product. In the east-central area there was a stainless steel manufacturing plant using chrome ore which is subjected to reduction in electric arc furnaces together with other materials to form chrome alloys. Near the central part of the city was a chemical plant manufacturing chromium compounds from chrome ore. In addition to these four industrial sources of chrome dust there was a possible emission from unloading raw materials from boats in the harbor located in the southeast section and from a natural ore deposit just over the city's northern boundary.

A sampling station was established closest to the chemical plant because of the health experience among its workers (8). A two-hour air sample was filtered through paper with automatic repetition for 24 hours a day for two months. A total of 736 samples were collected with the Automatic Smoke Sampler (9) and an analysis was made of each dust deposit. Concentration of the dust was reported in micrograms of chromic acid anhydride. A portion of the data collection appears in Figure 5. By plotting the concentration against the daily sampling hour the graph shows not only the average concentrations for the two-hour periods by a solid black wide line but also the maximum concentrations for all of the respective two-hour periods by a narrow line. It is noted that the two curves are quite similar and the the maximum concentration appeared between 1:00 and 3:00 P.M. while the minimum concentration was between 5:00 and 7:00 A.M. The major operations of the plant were performed between 7:00 A.M. and 4:00 P.M. and it should be noted that there was a quick build-up of concentrations at the sampling site located about 700 feet from the plant as the major daily operations began but that the fall-off after the operations ceased was of a gradual nature. Plant management believes that by careful observation of the data offending operations can be singled out so that a concerted effort can be made to reduce the effluent from the plant.

Futher use of the data appears in Figure 6 where wind direction is plotted against average and peak concentrations as well as against the number of samples. It will be noted that the maximum concentrations, both average as well as peak, appeared when the wind was from the southeast quadrant; in other words, when the wind was from the plant to the sampling station. The dotted curve is indicative of the wind directions for the entire sampling period between July and August, inclusive. It should be noted that the wind was predominantly from the south-southwestern portion of the compass. Another interesting facet appears that there is a background of chromium of the order of 0.08 micrograms of chromic acid anhydrid for a two-hour sample during which approximately one-half cubic meter of air was sampled. This is equivalent to 100×10^{-3} micrograms of chromium as metal per cubic meter of air and is in reasonable agreement with the average chromium concentration of 71×10^{-3} micrograms per cubic meter of air as reported for the 1957 network for the Baltimore Station.

SUMMARY AND CONCLUSIONS

It is seldom worthwhile to apply data collected for one purpose to another problem. Subjective data can often become helpful in furnishing unexpected leads to solutions of problems or to indicate where there may be a need for obtaining objective data to arrive at a sound conclusion. In some instances data of an informational nature such as complaints,

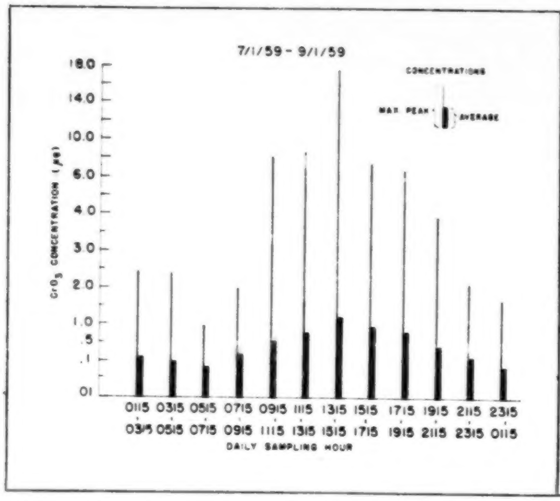

Figure 5. Atmospheric Chrome Dust Study

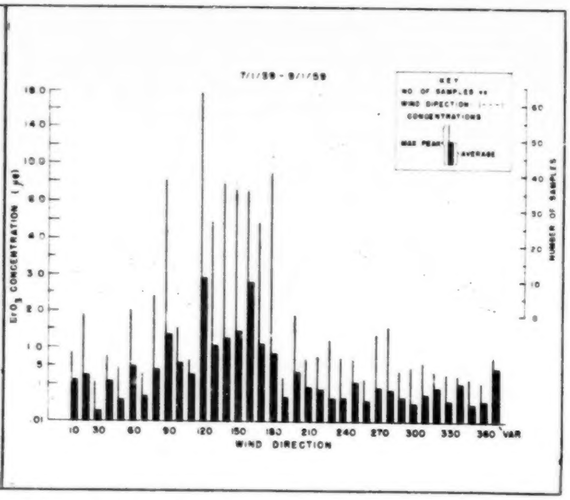

Figure 6. Atmospheric Chrome Dust Study

can be obtained inexpensively. On the other hand, technical data is more costly but if a program is well planned and the results are used judiciously such an approach to many problems results in considerable savings in obtaining effective equipment for controlling air pollution. Various examples are presented.

Sincere thanks is extended to Mr. C.E. Sachs, Civil Engineer, for preparation of the illustrative material.

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8. Health of Workers in Chromate Producing Industry. Public Health Service Publication No. 192.

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CHAIRMAN STERN: The use of data in epidemiological fashion, as has just been explained to us, is to my mind, the most exciting use of unexciting data I can imagine. This is the kind of usage to which we keep hoping the data will be put. To find that from time to time individuals studying the data find in it this kind of a gold mine from the point of view of public health justifies much of the effort.

Concluding remarks are going to be given by Mr. Frank DeMartini, the Deputy Chief of the Air Pollution Engineering Research Program here at the Sanitary Engineering Center. Mr. DeMartini.

INTERCHANGE AND RELEASE OF DATA

F. E. DeMartini

MR. DeMARTINI: Because of the close interrelationship of all the subjects discussed yesterday and today and since this topic is the last one on the program there already has been, as one would expect, an appreciable amount of comment and discussion on the release and interchange of information. It is good that we start with this background of previous comments and views because they serve, I believe, as some orientation to us in the topic we are to pursue now in more detail.

A number of approaches to the subject of release and interchange of information are possible. The one, which I shall follow, is a discussion first of release and publication of network results or data and second, presentation of some thoughts for your consideration on how the interchange of information and ideas regarding network operations might be accomplished.

RELEASE AND PUBLICATION OF NETWORK DATA

Atmospheric air quality data may and actually are being collected through air sampling networks by governmental agencies at the local, state and federal levels. The previous speaker has just completed a presentation on use of such data. One such use is the public release of the data itself and of data interpretations made by the collecting agencies. There are many good reasons for such releases - first it goes almost without saying that network results obtained through use of public funds should be made available to the public for its information. Further, the collecting agency actually has the responsibility to evaluate and interpret its data for the public. Release of air quality data, particularly if interpreted in readily understandable fashion, is perhaps one of the best means of assuring an informed citizenry, public interest in air pollution control, and in the final analysis adequate budgetary support for air pollution control programs.

Whether or not evaluation of data is made in public releases a benefit accrues through giving other interested parties the opportunity to see the data and to apply their evaluations and interpretations.

All too frequently we accumulate quantities of data in the laboratory and in field studies with the most sincere intent to analyze, interpret and release them but often fail in fully carrying through this intent. It is all too easy, under pressure of day to day operations, to put off detailed data evaluation and releases until more time becomes available to "do the job right." By scheduling regular public release of such information as network results, deadlines are set and in order to make the releases creditable and to justify the data collection effort the issuing agency will fulfill its responsibilities by making the effort required to interpret the data and present its evaluation in addition to release of the raw data.

Next it seems logical to consider briefly the ways in which network data and information may be released, the audience to which releases are directed and problems or questions associated with publication of results. In this area some of us have had specific experience and we can discuss these matters in the light of such experience. Naturally most of my references will be to the practices followed and experiences we have had in the Public Health Service in connection with release of data and information on the National Air Sampling Network. I believe that in general they should be similar to the experiences of state and local agencies.

In releases on Network results we are trying to reach two principal audiences: The technical or scientific group and the general public. To reach the former the technical paper presented at annual meetings of professional and technical organizations is generally used and is an excellent approach. Such papers are generally published and therefore constitute a part of the technical literature available to all those having professional interests. Another medium is the publication and release of specific reports on Network operations presenting primarily the data themselves with such statistical analyses as are productive in giving meaning to the data.

During the lifetime of the National Air Sampling Network there has been an appreciable number of technical papers released relating to the Network; most of them deal rather directly with data and data interpretations. I have listed these papers as an appendix to this report and will not now identify these papers in detail. Our only publication in the form of a special report is the 260 page report released at the time of the National Air Pollution Conference held in Washington, D.C. last year, entitled: "Air Pollution Measurements of the National Air Sampling Network 1953-57." Basically it provides summaries of results for suspended particulates for all network stations for the period 1953-57.

Another example of data release is the "Clean Air Quarterly", published by the Bureau of Air Sanitation of the California Department of Public Health. This publication was started in September 1957. The first issue pointed out that one of the most important reasons for the publication was to present a summary of air measurements being made in California and further that measurement data is of interest to all who are concerned with air pollution in California. It states concisely some of the benefits in release of data pertinent to our discussions here today and I should like to quote from the first issue of the quarterly: "Data from the various locations will help paint a statewide picture of air quality. We believe the summaries will be useful to people concerned with the control of air pollution, to those interested in the damage to vegetation, and to governmental officials and others who have a major concern with this problem. It is hoped that these summaries also will promote interest in air sampling, encourage uniform sampling methods and improve the information now available on the air quality in the state."

Now, with respect to the general public, though it rarely looks at the technical journals or special reports it is not necessarily uninformed regarding them. Newspaper coverage of professional meetings and reporter interest in national, state or local reports lead to articles in the daily press highlighting or summarizing many of these papers and publications for the layman. We must realize that this audience is also reached, then, to a degree even through technical issuances. With the rising interest in air pollution national magazines such as Newsweek, Saturday Evening Post, Life Magazine and others and free lance writers know that there is public interest in the stories that are based on air quality data and information. I believe it is through these channels that the general public becomes aware of and is primarily to be reached regarding air measurements and their significance as to air quality. It is our responsibility to see that these articles are as accurate as possible whenever we have the opportunity to work with the writers. An important public informational avenue in our experience with the National Air Sampling Network was found to be the local daily newspaper where articles regarding establishment of a network station are frequently published. Many articles appear describing the initiation of a sampling program, generally with pictures of local authorities and equipment supplemented at times with some actual air measurement values and statements about the local control program or the cleanliness or dirtiness of the air in the community.

I believe these are the principal audiences we deal with and the avenues used to reach them. What types of questions arise then in publication of data and of evaluations aimed at these audiences? Some that come immediately to mind are:

1. In what form should the data be released to the general public?

2. How should we view the matter of comparisons being made of one city's air quality with that of other cities on the basis of releases of air measurement data?

3. From the viewpoint of data releases what consideration should govern the inclusion of a community or state in an air sampling network?

4. What are the policy considerations associated with releasing network data collected through cooperating agencies or of specifically data pertaining to a community forming part of a state or national network?

Let us consider these particular questions, though there may be others as important, a little more fully at this point.

As mentioned previously, the public, either directly or indirectly, learns of information released on air quality measurements regardless of the avenue of release. Accordingly, a broad comment would be that any restrictions in releases could threaten the free publication of research findings, of technical papers, of compilations of network results, etc. Hence, any restrictions based on political expediency or on concern over unfavorable reaction by the public in being told the facts are believed to be untenable. The approach, in my opinion, is that no restrictions should be imposed. Rather, the releases should be carefully prepared at the start, they should be as complete as possible and valid interpretations only should be made. If correlations and interpretations are not made at all or if they have been attempted unsuccessfully this should be indicated and it should be made very clear that the results are released as obtained. In this case it might well be stated that too much confidence should not be placed in comparisons. If this is the case that changes are being made or are necessary in the particular operation to achieve meaningful or interpretable results at a future date, this should be pointed out.

Any picking and choosing of what should be released and what should be withheld will unquestionably result in bias and in distortion of the overall picture.

In releases of data and results on the National Air Sampling Network we have taken the position of not withholding publication of certain results. We have been subject to some criticisms in this regard but these have been few in number in comparison to the number of cities included in the Network and for which data has been released. The criticisms have been directed not so much at the actual release of the data as to the interpretations made after release by newspaper writers and others which leads us to the second question mentioned previously.

On this second question, (comparisons of data for various places) it seems inevitable that comparisons will be made among results reported for various network cities. This naturally leads, for one thing, to statements or news articles that one city is "dirty" compared to another. In turn, if the so-called "dirty" city has an air pollution program and staff, the local reaction could be, "Why are we not getting better results?", or in the "clean" city, "If our community air is so clean we should consider reducing staff or program support." These are some of the possibilities and problems in this area. What are the answers or solutions? I doubt that withholding the release of network data is the proper solution. It is believed that we should recognize that comparisons will be made and we should concern ourselves with the extent to which we should qualify the validity of the data and the characterization of the sampling site for comparative purposes. To hold that comparison of the data of two cities cannot or should not be made implies that they have no meaning for either city.

In the APCA News for September 1959 an item was printed regarding comparisons of dustfall data that it is pertinent to mention here. This item reads: "At a recent Board of Directors' Meeting, the following statement on dustfall, which had been formulated by the Control Officials Conference Committee, was presented. The statement reads: 'It has been noted that there has been a tendency to compare the cleanliness or non-cleanliness of a particular city with one or more other cities on the basis of the results of dustfall studies. Inasmuch as there is no accepted standard method of making such tests the practice of making comparisons between cities should be frowned upon by APCA and this disapproval should be given all possible publicity.' The Board expressed itself as being in accord with this statement and it is reproduced here for the information of the membership." The qualification made here is that data collected in various cities is not obtained by an accepted standard procedure, hence comparisons are not valid.

Regardless of the effectiveness of control activities some cities by reason of industrial activities, meteorological conditions, type of fuel used, geographical location, natural air pollutants, etc. will show higher particulate and/or gaseous pollutant loadings than others in a given network of cities. These facts are not always known to the public, to the city councilmen, the mayor and the newspaper reporter. The agency releasing network data, however, is aware of such factors and it can point them out in releases of network results to guide those attempting interpretations on their own or attempting to make headlines that are newsworthy or dramatic. When conditions in a particular place are actually poor, in spite of allowances for extenuating conditions either natural or otherwise, the truth will be known in any event by intelligent people and it can hardly be hidden or evaded by controlling the release of air measurement data. The release of information should actually, in such cases, be utilized to gain support and to emphasize the need for a more adequate program -- larger staff, budget, equipment, etc. or more effective control of emissions from significant sources.

The third of the questions I mentioned referred to the considerations that should govern as to the inclusion of a city in a network operation insofar as public release of data is concerned. It is believed that the only tenable policy on this point is that authorization to release data for all participating communities is a prerequisite to their inclusion in a network. Data which cannot be released is of little value and withholding it is contrary to the principle that the public is entitled to the data which is collected at public expense.

Our fourth question related to the considerations involved in release of data collected through cooperating agencies or more specifically of data for a community or state included in a network.

The aforementioned policy of "participation authorizes release of data", if accepted, in effect answers this question. The considerations here should not be those of "clearances" or "approvals" for data releases but really of assuring coordination of the activities among the participating agencies and of keeping them "informed" regarding proposed releases. Differences of opinions as to timeliness, vehicle of release, etc. can generally be resolved if information regarding planned releases is communicated to participants in a Network. If, however, they are not resolved, the issuing agency must still be free to publish results and assume the responsibility for the publication. Cooperating agencies should not be in a position of exercising the power of veto over publication of Network results.

INTERCHANGE OF INFORMATION AND IDEAS

During the remaining time I shall offer some thoughts regarding ways of accomplishing interchange of information and ideas on network operations as a whole as contrasted to release of data.

Obviously, since we have been here for two days doing just this thing, one means of exchanging information and ideas is at meetings such as this one. Before this meeting adjourns I believe there should be some expression on the part of those here regarding the value of this two-day meeting and the desirability of and the need for future meetings of this type.

Within the limitations of our resources in the Public Health Service the Air Pollution Engineering Program could serve as a clearing house or focal point for distribution of state and local data and information releases on a nationwide basis to all air measurement networks participants. Basically, the Service might serve as the distribution center for such materials doing the housekeeping and mailing chores in order to relieve the state and local agencies of these tasks and to assure widespread distribution of information of general interest.

The Public Health Service or continuing committees selected from among operators of networks could receive from the respective cities, states, or organizations forming a network information on such matters and practices as: Sampling site selection; sampling equipment; laboratory procedures; data evaluation and programs for statistical analyses; utilization made of data; network budgets.

Such information could be distributed generally to networks operators. In addition such a unit, whether a committee or the Public Health Service, could endeavor to digest information provided in these respective areas with the objective of developing recommended standards of practice.

It is of interest to note, in closing, that there are an appreciable number of air measurement networks currently in operation and more are likely to be established in the near future. This fact, once again, is known to you and one reason for the turnout for this two-day meeting. Some of these networks are those operated by:

CITIES, COUNTIES AND DISTRICTS

Alameda County Air Pollution Control District.
Allegheny County Bureau of Smoke Control.
Baltimore Division of Air Pollution Control.
Cincinnati Bureau of Air Pollution Control and Heating Inspection.
Cleveland Division of Air and Stream Pollution.
Contra Costa County Air Pollution Control District.
Detroit Bureau of Smoke Inspection and Abatement.
Fresno County Air Pollution Control District.
Los Angeles County Air Pollution Control District.
Milwaukee Department of Smoke Regulation.
Monterey County Air Pollution Control District.
New York City Department of Air Pollution Control.
Orange County Air Pollution Control District.
Philadelphia City and County Air Pollution Control Section.
Riverside Air Pollution Control Division.
Salt Lake City Board of Health.
San Diego County Air Pollution Control District.
San Francisco Bay Area Air Pollution Control District.
San Francisco Department of Public Health.
San Mateo County Department of Public Health.
Sonoma County Health Department.
Upper Ohio Valley Air Pollution Control Council.

STATES

California, Bureau of Air Sanitation - California State Department of Health.
Maryland, Division of Industrial Health and Air Pollution - Maryland State Department of Health.
Massachusetts, Division of Sanitary Engineering - Massachusetts Department of Public Health.
New Jersey, Bureau of Adult and Occupational Health - New Jersey State Department of Health.

New York, New York State Air Pollution Control Board.
Oregon, Oregon State Sanitary Authority - State Board of Health.
Pennsylvania, Division of Industrial Hygiene - Pennsylvania Department of Health.
Washington, Division of Engineering and Sanitation - State Department of Health.
U.S. Public Health Service.

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With the degree of interest and activity already evidenced it appears timely that we try to do something of a continuing nature toward increasing the exchange of information and ideas as well as the release of data.

I hope that some of the points I have made will stimulate discussion and that some of the controversial matters can be brought closer to resolution if not completely solved in discussions here today.

Appendix

U.S. Public Health Service Publications and Reports Based on the NASN

1. APER - National Air Sampling Network (Mimeo Report) Oct. 30, 1957.

2. USPHS - Air Pollution Measurements of the National Air Sampling Network. Government Printing Office, November 1958.

3. Chambers, L.A., Foter, M.J., and Cholak, J.: A comparison of particulate loadings in the atmosphere of certain American cities. Proc. 3rd National Air Pollution Symposium, Pasadena, California.

4. Chambers, L.A., Tabor, E.C., and Foter, M.J.: The characteristics and distributions of organic substances in the air of some American cities. AMA Archives of Industrial Health 16:17-26. July 1957.

5. Chambers, L.A., Tabor, E.C., and Foter, M.J.: Protein Content of the Atmosphere. Tech. Report A-58-9. SEC 1958. 42 pp.

6. Harris, E.K., and Tabor, E.C.: Statistical considerations related to the planning and operation of a national air sampling network. Proc. 49th Annual Meeting APCA, Buffalo, N.Y. May 1956. pp. 35-1 thru 35-18.

7. Lodge, J.P., Jr.: Composition of urban particulate air pollutants - the national air sampling network. Proc. 11th Industrial Waste Conference, Purdue University, Lafayette, Indiana. Eng. Bull. 41:418-425. Eng. Ext. Dept. Extension Ser. No. 91. June 1957.

8. Stern, A.C.: Application of Electronic Processing to Air Quality Data. Presented at Semi-annual Conference, APCA, San Francisco, Calif. Nov. 18-19, 1957.

9. Stern, A.C.: Results of three years of operation of the national air sampling network. JAPCA 7:284-288. Feb. 1958.

10. Stern, A.C., and Zimmer, C.E.: National Air sampling network program manual for the IBM 650 Computer. SEC 1958. 117 pp.

11. Stern, A.C. Changes in identity and quantity of pollutants, past and future. Proc. National Conf. on Air Pollution. Government Printing Office. 1959.

12. Tabor, E.C., Hauser, T.R., Lodge, J.P., Jr. and Burttschell, R.H. Characteristics of the organic particulate matter in the atmosphere of certain American cities. AMA Archives Ind. Health 17:58-63. Jan. 1958.

13. Tabor, E.C., and Warren, W.V.: Distribution of certain metals in the atmosphere of some American cities. AMA Archives Ind. Health 17:145-151. Feb. 1958.

14. Tabor, E.C. The national air sampling network. Univ. of Missouri Bull. 60:9-15. Mar. 1959. Eng. Experiment Sta. Eng. Series Bull. No. 42.

15. Tabor, E.C., and Meeker, J.E.: Effects of the 1956 steel strike on air pollution levels in several communities. SEC Tech. Report, A-60-2, 1960.

16. Zimmer, C.E., Stern, A.C., and Tabor, E.C. Particulate pollutants in the air of the United States. JAPCA 9, 136, (1959)

CHAIRMAN STERN: I would like a quick showing of hands as to whether you would prefer to have a discussion period without a break now, or whether you want to follow the schedule and have a 15 minute break and then come back here for discussion. I think most of you wish to adjourn. Be back here at 3:00 o'clock.

(A brief recess was taken.)

CHAIRMAN STERN: I am glad to welcome all you dedicated professionals who are remaining to the bitter end of this seminar back to our concluding session. The floor is open to questions and discussion, addressed to either Mr. Couchman, Mr. DeMartini, or anybody else.

MR. SCHREIBEIS: I wanted to ask Mr. Couchman if there had been any correlation made of the chromium concentrations in the atmosphere and possible health effects among the population.

MR. COUCHMAN: In order to allay fears, should that kind of speculative information fall within the hands of the public or public informants I mentioned, in the original draft of the paper, that statistically there were no differences in mortality rates between the cities from the chrome content in the air. After having made this statement and feeling as though that's what I should say and that's what I thought was correct, I decided five days ago to call our statistician to verify the statement. That afternoon he called me back and said, "You better strike that from your paper. Now, what I have is far from conclusive. I have to go into it much further, but there is a trend in the respiratory cancer rates between Baltimore and a few cities I have checked. It could be explained by any number of reasons, but we hadn't thought of it before and there may not be a thing to it." His parting remark to me was, "Don't mention it in your paper". Hence, the health affect from chrome is very uncertain but it hasn't been ignored. On the other hand, it would have been ignored if it had not been for the data that developed from the network.

MR. BELL: Well, this particular subject may be perfectly clear, and I have heard somewhat about it, but I wonder if anyone else here could elaborate on this. The motion of the Board of Directors concerning the release of information on air sampling network results it sounds to me, is that some cities felt they had been hurt by this information or by how the newspapers interpreted it. Was the motion for restraining this release for that reason?

CHAIRMAN STERN: I'd say the release speaks for itself. I don't think any of us are in a position to interpret the Board of Directors in adopting it. Mr. Pate.

MR. PATE: Could I carry that further and ask Mr. DeMartini to read back the text?

MR. DeMARTINI: Yes. The item that was published in the APCA News read this way: "At a recent Board of Directors' Meeting, the following statement on dustfall, which had been formulated by the Control Officials Conference Committee, was presented. The statement reads: 'It has been noted that there has been a tendency to compare the cleanliness or non-cleanliness of a particular city with one or more other cities on the basis of the results of dustfall studies. Inasmuch as there is no accepted standard method of making such tests the practice of making comparisons between cities should be frowned upon by APCA and this disapproval should be given all possible publicity.' The Board expressed itself as being in accord with this statement and it is reproduced here for the information of the membership."

MR. HATCHARD: Mr. Chairman, I was at the Board Meeting on that occasion and I would think that the majority of the Board was thinking of dustfall or particle fall only. Looking at it more realistically, I am quite certain the majority of the Board would agree with Mr. DeMartini's statement that regardless of what we do in our reports or in the news releases, cities and communities will be compared. The point, I think, should be that in prepared statements or prepared releases, we should try to say what the data means or does not mean, then the likelihood of comparisons being made on erroneous data would be much less. I think that's the main part of it.

A personal point, I would hate to see that any of the statement made by APCA was used to discourage the public release of data.

CHAIRMAN STERN: I would like to bring up one point that Mr. DeMartini raised in his remarks, and that is to use these concluding moments to sound you out as to your feelings concerning the need for get-togethers of this type among folks concerned with operation of networks at future times. Do you feel that this would be desirable?

MR. FERGUSON: I have one question. In being a generalist in environmental health, I guess I am not inhibited with a lot of scientific facts on air pollution, so I can afford to ask questions. I had hoped in coming to this meeting that I would learn a little about how to encourage or promote air pollution control programs, using the mechanism of the network. When a community joins the network equipment and installation advice is sent to the participating agency. Many times newspaper or TV people are invited to view the setting up of the equipment and often times articles are written concerning the participating station of the network. Sometimes everyone in town starts talking about the air pollution problem and they are told that it is necessary to wait for several months while information is being collected. After passage of several months the newspaper and TV people return and request information concerning the data obtained. They, along with other people, wish to know what these data mean. Do we have a dirty city? Do we have a clean city? How dirty is it and what effect is all this on the health of the community? Today I heard a lot about collecting data which would establish long-term trends, but very little about using this information to establish air quality upon which local programs could be based. I would have liked and still do to hear some comments by some of the people as to how to use the networks as established information, for the establishing or promotion of air pollution control programs on a local area.

CHAIRMAN STERN: Does anybody want to answer that one? I will ask the obvious person to answer that, Mr. Jean Schueneman.

MR. SCHUENEMAN: You can use air quality data, I think, to demonstrate to a community whether or not their city is cleaner or dirtier than another city, notwithstanding the fact that a single station doen't represent pollution levels over the entire city. You can say that the data represent a sample that was collected in the city, so the pollution indicated did exist in that city. A concentration at a single station in another city exists there. If types of areas where samplers were located are at all comparable, in my opinion you won't go too far wrong. Of course, you can sample at various places in a city and get two or more times variation in pollution levels.

For public information purposes, you can compare one city with another city doing the best you can to explain the true significance of the data presented.

You can't in most cases tell the people that a certain level of pollution is or is not damaging to health with information we have at present. You can reflect on this aspect and say that there is increasing evidence of a connection between air pollution and adverse effects on health. You can indicate that relatively high or relatively low pollution levels have a varying capacity for dirtying materials, thus affecting laundry bills and so on.

Air quality data and air sampling programs can be used as tools in gaining interest in air pollution, as you mentioned. The press, radio, and TV are usually willing to give time or space to such things and this gets the subject of air pollution before the public. If you can get a community organization interested, you can make air pollution the subject of meetings. You can use air quality data as starter material to get people to attend a meeting to discuss air pollution, saying the results of the sampling program are available and perhaps we can examine the local air pollution situation in light of this data and determine what control activity is needed.

You can reinforce air sampling data with other data. Perhaps you already know of a number of sources of pollution about which there have been complaints. Most communities have such records. You can reinforce it with some photographs of pollution sources or effects and use all this as a starting point for community activity by such groups as the Chamber of Commerce, the PTA, industrial associations, ladies' garden clubs and labor unions.

MR. COUCHMAN: Would it be unreasonable to release such data? Certainly I am in favor of letting the public have it, but perhaps it should be prefaced with an explanation. After all, I think you can truthfully say this data represents in numbers just what the situation is, but then explain what some of the other variables are because people are so prone to look at data of this nature and say it is industrial in nature. We know that's not necessarily true. It could be from natural causes. It could be due to the ventilation rates of a particular city, some cities having much better rates than others. These conditions could be explained in a preface accompanying the tabulated data, or better still if someone here in the Center would write a paper and have it published on the interpretation of the data, I think it would be helpful.

MR. SCHUENEMAN: I mentioned that there were some fairly easy ways to get reinforcing information for air sampling data. With fair accuracy an estimate of emissions to the atmosphere for a given community can be made. You can find out how much of each type of fuel is burned, how much refuse is burned, how much automotive fuel is burned, and pretty quickly get together an emission inventory from combustion operations. Depending on the community combustion effluents may be from 50 to 85 per cent of the total emissions to the atmosphere. Emissions from other types of sources can be estimated but not as readily. These estimates can be used as an indication of the sources of the largest contributions to total pollution.

Using this emission data, wind velocity data, and values for inversion heights it is possible to make an estimate of air concentration of pollutants and pretty often come close to what is actually measured.

MR. KOCH: I would like to add to this discussion a bit from the psychological angle concerning the customers, the people in our neighborhood we are trying to serve. If we do establish a station (and we are just in the process of establishing a station) you can very well peddle this idea as an additional piece of evidence of interest by the official agencies in the well-being of the community. We think enough of them to establish this point, at least to make a survey answer of the area possible. Right now we have nothing. We don't know. Somebody calls us to ask how much Sr 90 we are getting and we don't know. We won't be able to tell them later on anyhow, specifically. The important part is that we need to have some sort of a thing we can point to as evidence that we are doing something along the lines of air pollution. Whether it is particularly necessary in that community or not, remains to be seen. We don't know now. The other thing, of course, is the value of joining a national network. This goes over big with quite a few people, that they are part of a big deal. Others, of course, view it differently; but you always get two schools of thought in any of these things.

I think we can make ample use of the fact that we would have such a station. As far as the local sources are concerned, invariably the people will pinpoint them anyhow, by means of subjective measures such as complaints. They know where they are, and they point their finger at them and they will expect us to do something about them anyhow. But we want to bring out that there is also a total community pollution generation, shall we say, or a total community source of air pollution over and above the individual sources, and expecially in areas where there isn't much industry. People start to feel a little bit virtuous around those areas: "Well, we are living in a clean community." To bring home to them that the act of daily living, of fuel burning, of automobile driving, and even of backyard burning adds to the total load, this might be quite helpful and shake them up a little bit in their virtuousness.

MR. SCHUENEMAN: I haven't heard comment on one other purpose of monitoring that might be worth consideration. It would be reasonable to expect that the effects of air pollution on health will be related to long-term exposures to certain levels of pollution. If we start monitoring now, before health effects are determined or shown to be present in a given community, and five years hence we find that a certain level of pollutants over a certain period of years can cause a given health effect, we will have pollution data for use in study of possible health effects at the future time.

CHAIRMAN STERN: Any more comments? If there aren't, I'd like to ask Elbert Tabor, whose meeting this is, to come forward and pronounce the benediction.

MR. TABOR: We are very happy that you felt it worthwhile to come to visit us for this two-day meeting. It has been very nice to have been able to talk to so many friends of the network. I think we are all on very good terms.

I have transacted quite a bit of business with some of you. I have talked you into doing more work and, from my standpoint, I have accomplished a great deal. I didn't have to use too much pressure.

As you know, we are planning to publish the proceedings of this Seminar. This will be mailed to you when it is complete. You that have made formal presentations will have an opportunity to modify your statements and correct your papers.

We will send you a group photograph too, but we may attach a string to that before you get the photograph. We may take this opportunity to get a statement from you regarding your opinions on the seminar. Personally, I feel this meeting has been very much worthwhile. I hardly knew what to expect from the various speakers, but they performed wonderfully well, and on behalf of the Center I wish to express our appreciation for their contribution to the seminar. So let me say again that we are very happy that you came. We hope all of you have a pleasant journey home and we hope to see you again soon.

(Thereupon, at 3:30 o'clock p.m., the meeting was adjourned.)